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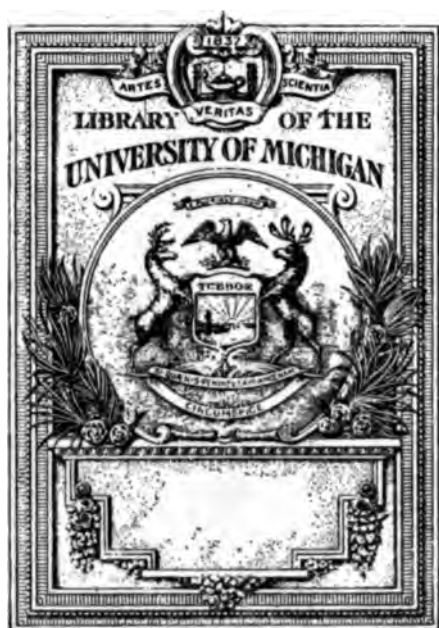
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or less unknown or forgotten. These brief records of the Mines and Minerals is the first of the series, while the second on the Marbles and Limestones is now in the printer's hands. A third on Clays and Slates is almost complete; while the materials for others are being collected. The Council of the Royal Geological Society of Ireland has arranged to publish each consecutively as parts of the eighth vol. of their Journal, all eventually going to complete an Economic Geology of Ireland.]

The lists of mines published by Griffith in the *Dublin Quarterly Journal of Science* (1861) were corrected and revised in chap. xxi. section v., pp. 361, &c., of the *Geology of Ireland* (1878); but these now require revision. It is therefore proposed to again revise and, at the same time, to re-arrange them, first giving separate lists for each mineral arranged in counties, or in "fields" where the ores are bedded; with, subsequently, short County Histories of the mines; thus dividing the subject into two parts.

In both parts the Counties, as far as possible, will be arranged alphabetically. In Part I. the lists include all the places where the different minerals are recorded as found in appreciable quantities; and in Part II., when possible, the present state of the lodes will be stated; but in both Parts, in the majority of cases, the information given as to the work done, on account of the unsatisfactory way in which the old mining records and statistics were kept, will be on hearsay evidence. The statements, therefore, cannot be taken as perfectly satisfactory, as a large portion may require to be substantiated.

The history of the early Irish mining adventures is very scant, the records being vague. The ancient mines are referred to by Griffith, Kane, and other modern explorers; but necessarily the remarks had to be more or less vague, and do not give much information. Griffith, however, states:—"Many of our mining excavations exhibit appearances similar to the surface workings of the most ancient mines in Cornwall, which are generally attributed to the Phœnicians."

The late R. Rolt Brash published an interesting Paper on "The Precious Metals and Ancient Mining in Ireland" (*Journal*

Roy. Hist. Arch. Ass. Ireland, vol. i., fourth series, p. 509); but it more particularly refers to the "finds" of gold and silver articles; these metals having been worked and mined at an early date. Bronze implements are also very ancient, and possibly iron; but the latter metal corrodes away so fast that all ancient implements must have disappeared long since; though traces of them may sometimes be found. It may be mentioned that deep down among the records of the earliest inhabitants of the large crannog in Lough Rea, Co. Galway, I found a rod of rust that evidently was the remains of an iron implement; it must have been 2000, or 3000, or more, years old.

Of Ancient Metal Mining, or its Adjuncts.—A very early record occurs in the *Annals of the Four Masters*, A. M., 3656, where gold is mentioned as procured in *Foithre Airthir Liffe*, or in the mountains of Dublin and Wicklow; while at *Lyra, Knockmiller*, about two miles southward of Woodenbridge, Co. Wicklow, the ancient timberings in a placer mine were found. We also learn from the *Annals* that in A. M. 3817 silver shields were made at *Argetros* (Silverwood) on the Nore, Co. Kilkenny. In this neighbourhood are the remains of ancient mines at Ballygallion and Knockadrina—places at which in recent years native silver has been found. It appears probable that, in those early times, some at least of the silver was procured at those mines; there are, however, other prehistoric mines that probably were also sources from which silver was procured. There is also mentioned in the *Annals*; silver, got at *Rosargid* (which also means Silverwood, near Toomavara, Co. Tipperary. That name has not descended to us; but at Garrane, adjoining *Kilnafinch*, a little southward of Toomavara, is the debris of an ancient mine, locally called the "Silver Mine." Further westward, south of Nenagh, are the village and mines of Silvermines. Some of the mines at this village were worked so long ago, that when opened, about the year 1860, the attals (*pyrite* and *sphalerite*) in the stulls and old levels were found to have undergone a complete chemical change—into peroxide of iron, with carbonate and silicates of zinc. In recent years some of the lead from this locality has given as much as eighty ounces of silver to the ton, in addition to some native silver. Still, further westward, at *Garrykennedy*, on Lough Derg, "old men's workings" were broken into about the year 1855, and in them were found a

man's skeleton and the remains of wooden and stone tools. To the westward of the Shannon, at *Milltown*, near Tulla, Co. Clare, a mine was worked in ancient times. Here there is native silver; the oaken shovels and large iron picks found suggesting that the workings were not as old as some of the others. At *Carhoon*, near Tynagh, Co. Galway, there are the relics of an ancient mine of which the traditions are extinct. In south-east Ireland, at the *Magpie* or *East Cronebane* (Ovoca), Co. Wicklow, there are "old men's workings," on the "gossan lode," and in them were found stone and wooden implements. Here native silver was also found.

From so many of these ancient mines being on silver-lead lodes, it may be suggested that the "old men" understood a process for separating the silver from the lead.

Nennius, who wrote in the ninth century, mentions the mines of Lough Leane, Killarney; while about the year 1804, when Col. Hall was working the lead mine at Ross Island, he found primitive levels, stone implements, and other records of ancient work.

At Derrycarhoon, near Ballydehob, Co. Cork, in an old working, there were wooden and stone implements, a curved tube of oak, and a primitive ladder—the latter being an oak pole, with rude steps cut in its sides. This working must have been very ancient, as when found all traces of the surface entrance were smothered up by a growth of peat, over fourteen feet deep; this ought to represent a period of, at the least, 3000 years or more (p. 121).

About the year 1850 wooden tools, shod with iron, were found in ancient galleries, in connexion with the coal seam of the Ballycastle coal-field, Co. Antrim; while wooden scoops were found in an old working for bog-iron in the Queen's County, some of them being now in the Royal Irish Academy Museum.

During the rush after Irish mines, about twenty-five or thirty years ago, their characters were considerably prejudiced, and the working of them retarded, by a class of "Promoters," who misrepresented them; also by incautious Analysts, who represented the ores more favourably than they were entitled to. Such proceedings are most damaging to a mine; for although it may be good of its kind, and be capable of paying well, if judiciously worked, when it cannot give the "riches" promised, it gets into disrepute; or, if it is injudiciously over-worked, to try and keep up its

fictitious character, it will be robbed and its future prospects ruined.

In the history of the mining during those years, it is now well known, that more than one Promoter exhibited specimens as representing the ordinary minerals of a lode, while in reality his sample exhausted all the mineral of that class to be found in the veins. Also, some Analysts, after examining a specimen, allowed their analyses to be published as if they were the "representative analyses," although they were ignorant whether the portion submitted to them was a true specimen, representing the average ore of the lode, or a picked one that only represented its riches. An honest, true representation of the value of the minerals of a lode is most important, and the neglect of such, or the intentional misrepresentation of the value of the lode, has led to most disastrous results, not only in Ireland, but all over the world. Careless analysts and intentional misrepresentations cannot, therefore, be too highly censured.

In drawing out the lists of Irish mines and minerals the products have been arranged in the following order:—Gold, tin, native silver, lead and zinc, copper, sulphur ores and gossens, barytes, iron, manganese, antimony, arsenic, cobalt, graphite, nickel, titanium, molybdenite, alum and copperas, apatite, salt and gypsum, steatite and pyrophyllite: the products being arranged as much as possible in regard to the natural grouping of the ores in the veins.

Some of the minerals in the above list have been very sparingly looked after, and their occurrence may be much more frequent than is hereafter mentioned, as the lists are compiled from the localities observed and recorded by the different explorers. This may be specially the case in reference to some minerals that, although observed, have not been recorded. Boate, in his notice of the silver mines, Co. Tipperary, records quicksilver as found prior to 1640. In modern times no trace of this ore is recorded.

Some of the Irish rocks are said to be Pre-Cambrian, but the only pretension for classing them as Laurentians is *their lithological characters*. Some of these so-called Pre-Cambrian, both Petrologically and Palæontologically, are evidently, in one case Ordovician and in another Cambrian; while elsewhere they apparently belong to one or other of these periods.

PART I.—LIST OF THE IRISH MINES AND MINERALS.

[The localities where there were mines or trials are printed in *italics*. The nearest town and the names of the Rock-formation are given in the column of Remarks.]

GOLD.

COUNTIES.	No. of Copper Shets.	LOCALITIES.	REMARKS.
Antrim.		Slieve-an-Orta.	Glendun— <i>Diluvium</i> .—Said to have been found about thirty years ago in Glendun burn.
Carlow.		<i>St. Mullin's.</i>	<i>St. Mullin's—Diluvium</i> .—The exact place where the gold was found is unknown, but it is supposed to have been in the streams of Slievebaun (White Mountains).
Cork.	147	<i>Carrigacat or Dhuroda.</i>	Crookhaven— <i>Yellow Sandstone, or Devonian</i> .—In the gossan of the copper loads. Near Ballydehob, in this promontory, is the copper mine of Skeaghanore (<i>whitethorn bush of the gold</i>). No gold, however, has been recorded from this mine.
"	148	<i>Kilcrohane (Sheep Head).</i>	
Donegal.	107	Knaderlough.	Ballyshannon— <i>Cambrian (?)</i> .—See County Histories.
Dublin.		Ballinascorney and Rathfarnham.	Dublin— <i>Diluvium</i> .—In the gravel of the River Dodder.
Londonderry.		Moyola River.	Draperstown— <i>Diluvium</i> .—This is a locality mentioned by Gerrard Boate, A.D. 1652; but no gold has been found in recent years. The nature of the rocks and minerals in the county where this river rises would suggest the possibility of there being stream-gold in the valley.
Wicklow.	40	<i>Darragh-water or Aughrim River.</i>	Woodenbridge— <i>Diluvium</i> .—In the gravel of this valley and the tributary valleys; namely, Goldmine valley and its tributaries, Kilacoran stream, Coolballintaggart stream, valley of the Ow and its tributaries, and the Kilmacreddan burn.
"	34	Ballymanus.	Aughrim— <i>Metamorphic Ordovician</i> .—Particles of gold in a quartz vein, discovered by <i>Gerrard A. Kinahan</i> .

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Wicklow.	35	Castlemacadam.	Ovoca— <i>Diluvium</i> .—In the gravel of the Ovoca river; south of the Railway Station.
"	35	Ballymurtagh.	Ovoca— <i>Ordovician</i> .—In the gossan and gossan lodes of the mines on the <i>Ovoca mineral channel</i> gold has been detected; also in places in the regular ores of the lodes. The gossan lode of East Cronebane (<i>Magpie Mine</i>) seems to have been richest. In places, the Kilmacooite, or "Blue-stone," of the Magpie and Kilmacoo are also auriferous.
"	35	Tigroney.	
"	35	Cronebane.	
"	35	Connary.	
"	35	Kilmacoo.	
"	40	Ballycoog.	
"	40	Bullinasilloge.	
"	39	Moneytiegne.	
"	8	Greystones.	Greystones— <i>Glacial drift</i> .—In the washings of the sea-cliffs to the northward of the village; associated with black magnetic sand.
"	8	Bray Head.	Bray— <i>Cambrian</i> .—Particles in a small quartz vein, discovered by <i>Francis Codd</i> .
Wicklow and Kildare.		Liffey and Slaney Valleys.	<i>Diluvium</i> .—According to the <i>Annals</i> , gold "placers" were worked in the valley of the Liffey, and probably also in the valleys of the head waters of the Slaney. The river systems of the Slaney and Liffey have changed from what they were originally; as at one time the Liffey occupied the valley from Ballymore-Eustace to Baltin-glass, and joined there into the Slaney valley. This change cannot have been at a very distant period. The Slaney also at one time seems not to have gone through the Granite range; but at Tulla to have gone south-westward. This, however, was a much earlier change, as the river was banked into its present course by the "Esler sea gravel." The ancient workings are supposed to have been somewhere near Ballymore-Eustace. Places that gold might be looked for are: in Glenimale and the other head valleys of the Slaney; and in the ancient river course of the Liffey between Ballymore-Eustace and Baltimore.

TIN.

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Wick.	23	Dalkey.	Kingstown— <i>Grangyle</i> .—With lead and zinc. The mine worked for the lead. The only place in Ireland where tin is at present known to have occurred as an ore in a lode. It is reported to have been found at Kilcrohane (Sheep Head), Co. Cork, but the find has not been authenticated.
Kerry.		Lough Leane (?)	Killarney— <i>Devonian</i> ?—Although tin has not been found here in recent years, Nennius, writing in the ninth century, <i>Historia Britonum</i> , mentions tin, lead, iron, and copper, as occurring in this vicinity. All of these except the tin have since been found and profitably worked. Smith, in his <i>Natural History of Kerry</i> , states he found an ore containing tin near the lake, but does not give particulars.
Wicklow.	40	Goldmine River.	Woodenbridge — <i>Diluvium</i> . — With stream-gold and magnetic sand. In this locality there is possibly a lode containing the tin, but it has still to be discovered. [See "On the Possibility of Gold being found in the Co. Wicklow," <i>Sci. Proc. Royal Dublin Society</i> , February, 1883.]

NATIVE SILVER.

In the following lodes and localities, native silver has been found, but only in small quantities. Silver-lead (*argentiferous galenite*) occurs in numerous other places, and in a few places silver-copper (*argentiferous chalcopyrite*):—

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Wex.	35	Milltown.	Tulla— <i>Carboniferous</i> . — Ancient lead mine, in which were found stone and wood implements. NOTE.—A "silver mine" is recorded in James I.'s time "adjacent to the O'Loughlin Castle," in the barony of Burren. The ore, however, was probably silver-lead.

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Cork.	147	<i>Boullysallagh.</i>	Crookhaven — <i>Devonian</i> . — Associated with lead and copper ores.
Dublin.	26	<i>Ballycorus.</i>	Goldenball— <i>Granite</i> .—With lead ore. A large piece was accidentally put into the smelting-pot with the lead ore, and the silver ran into the brick-work of the furnace (<i>Kane</i>).
Galway.	122	<i>Caherglassen.</i>	Gort— <i>Carboniferous</i> .—With lead ore. Pieces said to have been of a fair size.
„	107 and 117	<i>Carhoon</i> (?)	Tynagh— <i>Carboniferous</i> .—A very ancient mine, possibly one of the silver mines mentioned in the early Annals.
Kerry.	30	<i>Lissooleen.</i>	Tralee — <i>Carboniferous</i> . — Threads and particles of silver in the lead ore.
„	30	<i>Clogher.</i>	Castleisland — <i>Carboniferous</i> . — Threads of silver in the lead ore.
Kilkenny.	32	<i>Ballygallion.</i>	Inistioge— <i>Carboniferous</i> .—A very ancient mine, supposed to be the <i>Argentos</i> (<i>Silverwood</i>) of the Annals, when silver shields were made, A.M. 3817.
Leitrim.	7	<i>Twispark.</i>	Lurganboy — <i>Carboniferous</i> . — In minute specks and strings in the lead ore.
Limerick.	11	<i>Ballysteen</i> or <i>Ballycanauna.</i>	Askeaton— <i>Carboniferous</i> . — Thread of silver in the lead ore.
Sligo.	20	<i>Abbeystown.</i>	Ballysodare — <i>Carboniferous</i> . — Strings and particles in lead ore.
Tipperary.	22	<i>Garrane.</i>	Toomavara. — <i>Carboniferous</i> . — Adjoining the mearing of Kilnafinch there is a very ancient mine, supposed to be the <i>Rosargid</i> (<i>Silverwood</i>) of the Annals.
„	26	<i>Silvermines.</i>	Nenagh— <i>Carboniferous</i> .—Very ancient mine. In these mines and the newer mines to the westward at Shallee, native silver associated with lead, and in some lodes with copper.
„	26	<i>Shallee.</i>	
Wicklow.	35	<i>Cronebane.</i>	Ovoca— <i>Ordovician</i> . — Associated with the lead ore of the Gossan lodes, and with the Kilmacooite. See <i>Lead ore List</i> .
„	35	<i>Connary.</i>	
„	35	<i>Kilmacoo.</i>	

LEAD AND ZINC.

[Except in a few localities the ores of zinc are accompanied by those of lead. In many places are found more or less grouped together the sulphides of lead (*galenite*), zinc (*blende* or *sphalerite*), and iron (*pyrite* or *sulphur ore*), and more seldom the sulphides of copper (*chalcopyrite*), arsenic (*arsenopyrite* or *mispickel*), and antimony (*stibnite*), with the sulphate of baryta (*barite*). The lead ore is often argentiferous, and in a few places the copper ore. In some places are found the carbonates of lead (*cerussite*), zinc (*calamine*), and copper (*malachite*), also the silicate of zinc (*Smithsonite*).]

COUNTIES.	No. of Census Sheet.	LOCALITIES.	REMARKS.
Armagh.	25	Carrickgallogly.	Belleek—Ordovician.—Lead.
"	25	Drumnahoney.	
"	23	Dorsay.	Crossmaglen—Ordovician.—Principally lead.
"	31	Tullyard.	
"	19	Clay.	Keady—Ordovician.—Principally lead. At Clay there is also manganese. At Carryhugh Glen there are two silver-lead lodes, called the <i>Red</i> and <i>Blue lodes</i> ; the first being in a ferriferous stuff, and the other is a bluish flucan.
"	19	Doohat, or Crossreagh.	
"	19	Drummeland, or Derrynoose.	
"	19	Carryhugh.	
"	19	Darkley.	
"	19	Tullyhawood.	Middletown—Ordovician.—Lead.
"	15	Tamlaght.	
"	22	Drumbanagher, or Church Glen.	Newry—Ordovician.(?)—Lead.
"	25	Ballintemple.	Newtownhamilton—Ordovician.—Lead.
"		Finiakin.	Cullyhanna—Ordovician.—Lead.
"	22	Kilmonaghan.	Goragh Wood (Gerrard's Pass)—Ordovician.—Lead.
"	13(?)	Ballymore.	Poyntzpass—Ordovician.(?)—An ancient mine; its exact site being now undetermined.—(Griffith.)
Cavan.	22	Cornanurney.	Cootehill—Ordovician.—Lead and silver-lead.
"	22	Cloghstrukagh.	
"	22	Drumfaldra.	South-east of . . —Ordovician.—Lead.
"	29	Shercock.	
"	10	Ortnacullagh (Ballyconnell).	Belturbet—Carboniferous.—Silver-lead.
Clare.	6	Cappagh.	Ballyvaughan—Carboniferous.—At Cappagh there are silver-lead, copper, and manganese. At Sheeshodonnell only carbonate of zinc, which occurs in botryoidal masses. At Lisnauroum copper is associated with the lead; while in the other localities lead only is recorded.—See note, <i>Native silver</i> , Co. Clare.
"	6	Moncen.	
"	6	Ailwee.	
"	6	Mogahy.	
"	6	Glencrawne.	
"	6	Sheeshodonnell.	
"	8	Lough Aleemaun.	
"	9	Lisnauroum.	
"	8	Doolin Castle.	

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Clare.	19 & 27	Glendree.	Feakle— <i>Ordovician</i> .—Lead.
"	24	Carroonakilly.	Newmarket-on-Fergus— <i>Carboniferous</i> .
"	42 & 51	Rathlaheen West.	—At the first the ore was silver-lead, while at the second it was associated with sulphur ore.
"	51	Newmarket.	
"	24	Ballyhicky.	Quin— <i>Carboniferous</i> .—Pockets of lead-ore occurred at these places; they are now worked out. They consisted principally of silver-lead. At Monanoe, or Kilbreckan, the peculiar mineral called Kilbreckanite was found, in which lead and antimony were mixed in such proportions as those used for printers' type.
"	24	Castletown.	
"	24	Moyreisk.	
"	24	Monanoe, or Kilbreckan.	
"	26	Ballyvergin.	Tulla— <i>Carboniferous</i> .—Silver-lead principally. At Ballyvergin there was also copper and sulphur ore. At Milltown, a very ancient mine, native silver occurred; while at Carrabin tumblers only have been found. The deposits in general seem to be worked out; but near Ballyvergin and Milltown are untried calcspar veins.
"	24	Knockaphreagh.	
"	25	Milltown.	
"	25	Carrabin.	
"	4	Crumlin.	Broadford— <i>Ordovician</i> .—Supposed to be worked out—silver-lead principally.
"	8	Doolin.	
"		Ballykelly.	
"	51	Rathlaheen South.	Sixmilebridge— <i>Ordovician</i> .—Lead and sulphur ore. Tumblers of lead were found at Gallows Hill, close to the western continuation of the great fault of Silvermines, Co. Tipperary. — <i>See list, Co. Tipperary.</i>
"	43	Knockanaghta.	
"	27	Ballyhurly.	Tomgraney— <i>Ordovician</i> .—Principally lead.
"	29	Cahir.	
"	29	Ballynagleragh.	
Oork.	127	Kilkinnikins.	Bearhaven— <i>Carboniferous Slate</i> .—Lead. In the latter townland traces of lead and copper in different places.
"	115 &c.	Killaconenagh.	
"	118	Gortacloona.	Bantry— <i>Carboniferous Slate</i> .—Silver-lead, silver-copper (<i>grey copper ore</i>), iron (<i>chalybite</i>), copper, and arsenic.
"	117	Killovernage.	
"	117	Rooska.	
"	117	Lissarraig.	
"	140	Ballycummiak.	Ballydehob— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Lead and copper. At Ballycummiak, also barytes.— <i>See Copper list.</i>
"	140	Kilkilloon.	
"	140	Leheratanvalley.	

COUNTIES.	No. of Ordinan- ce Sheet.	LOCALITIES.	REMARKS.
Cork.	144	Cooahoon.	Skull— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Lead, copper, and iron.
"	147	Boulysalagh.	Crookhaven— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Lead and copper. Silver-lead and silver at Boulysalagh.
"	147	Kilmoe (Spanish Cove).	
"	133 & 134	Cooladerreen.	Leap— <i>Carboniferous Slate</i> .—Silver-lead.
"	143	Rabbit Island.	Castletownsend— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Lead, antimony, and copper.
"	144	Dunam.	Clonakilty— <i>Carboniferous Slate</i> .—Lead, barytes, and copper. Worked principally for barytes.
"	99	Ringabella.	Nohaval— <i>Carboniferous Slate</i> .—Silver-lead and lead.
"	29	Minane.	
"	75 & 76	Carrigtohill.	Vicinity of . . — <i>Carboniferous Slate</i> .—Lead and zinc.
Donegal.	106	Bundoran.	Vicinity of . . — <i>Carboniferous</i> .—Lead and copper traces.
"	107	Abbey Island.	Ballyshannon— <i>Carboniferous</i> .—At the first three, silver-lead, zinc, and copper; at the others principally lead. At Carricknahorna also iron; worked in 1883.
"	107	Abbey Lands.	
"	107	Finner.	
"	108	Ballymagrorty.	
"	108	Carricknahorna.	
"	107	Tonreges.	
"	68	Wolshtown.	Ballybofey— <i>Metamorphic Ordovician</i> (?)—Lead and iron.
"	20	Carrucmore, or Glentogher.	Carndonagh— <i>Cambrian</i> , or <i>Ordovician</i> .—Silver-lead, zinc, and sulphur ore.
"	17	Fanad.	Glinak— <i>Cambrian</i> . (?)—Lead and copper traces.
"	26	Drumreen.	Carrigart— <i>Cambrian</i> . (?)—Lead.
"	16 & 26	Ards.	Dunfanaghy— <i>Cambrian</i> , or <i>Ordovician</i> .—Lead, copper, and sulphur ore. Except at Ards, the lodes were worked out by the Mining Co. of Ireland.
"	33	Kesldrum.	
"	15	Marfagh.	
"	74	Drumnacross.	Glenties— <i>Ordovician</i> .—Lead, zinc, and sulphur ore; but principally lead. In Scraig Mountain traces of lead and copper.
"	66	Fintona, Loughnam-bredan.	
"	65	Gweebarra River.	
"	do.		
"	74	Kilrean.	
"	74	Mullantiboyls.	
"	66 & 67	Scraig Mountain.	

COUNTIES.	No. of Square Sheet.	LOCALITIES.	REMARKS.
Donegal.	64	<i>Iniskeel.</i>	Naran— <i>Ordovician</i> . (P)—Lead and copper.
"	89	<i>Malinbeg.</i>	Killybegs— <i>Ordovician</i> . (P)—Silver-lead and manganese.
"	44	<i>Derryveagh</i> (Gartan).	<i>Church Hill</i> — <i>Cambrian</i> . (P)—Lead.
"	53	<i>Knockybrin.</i>	Letterkenny— <i>Ordovician</i> .—Lead at the mearing of Knockybrin and Woodquarter.
"	53	<i>Woodquarter.</i>	Further northward tumblers of lead in Lough Gannon.
"	45	Lough Gannon.	
"	51	Owenbeg, Glendowan.	Fintown— <i>Arenid</i> or <i>Cambrian</i> . In Glendowan, lead; at Glenaboghill, silver-lead.
"	53	Glenaboghill Lake.	
Down.	53	Glasdrumman.	Annalong— <i>Ordovician</i> .—Lead and copper.
"	45	Ardtole.	Ardglass— <i>Ordovician</i> .—Lead. At Gun's Island, also, copper and barytes.
"	89	Gun's Island.	
"	48	<i>Fofanny.</i>	Bryansford— <i>Ordovician</i> .—Lead.
"	55	<i>Leitrim.</i>	Kilkeel— <i>Ordovician</i> , and <i>Granite</i> .—Lead with, in places, copper.
"	53	<i>Mourne Mountains.</i>	
"	&c.		
"	44	Ballydargan.	Killough— <i>Ordovician</i> .—Lead, with barytes at Rathmullen.
"	45	<i>Killough.</i>	
"	45	<i>Rathmullen.</i>	
"	45	<i>Rathdrum.</i>	
"	48	<i>Moneylane.</i>	Dundrum— <i>Ordovician</i> .—Principally lead.
"	48	<i>Wateresk.</i>	
"	31	<i>Corporation.</i>	Killyleagh— <i>Ordovician</i> .—Lead.
"	31	<i>Tullyrally.</i>	Strangford— <i>Ordovician</i> .—Lead and copper; also zinc at Castleward.
"	31	Castleward.	
"	31	Dromore.	Vicinity of . . — <i>Ordovician</i> .—Lead and manganese.
"	6	<i>Whitepots</i> (Conlig).	Newtownards— <i>Ordovician</i> .—Lead. A peculiar lode. A highly metalliferous whinstone dyke, so rich with lead that it could be profitably worked as an ore.
"	1	Ballyleidy.	Crawford's burn— <i>Ordovician</i> .—Lead.

COUNTIES.	No. of Ordance Sheet.	LOCALITIES.	REMARKS.
Dublin.	14 & 18	Ashtown.	Dublin— <i>Carboniferous Limestone (Calp division)</i> .—Lead was the principal ore, except at Dolphin's Barn, where there was also zinc. The lodes at the places printed in italics are supposed to be worked out.
"	17	<i>Castleknoek.</i>	
"	14	<i>Cloghran.</i>	
"	19	<i>Clontarf.</i>	
"	19	<i>Killester.</i>	
"	23	<i>Crumlin.</i>	
"	18	<i>Dolphin's Barn.</i>	
"	13 & 17	<i>Kellystown.</i>	
"	18	<i>Kilmainham.</i>	
"	18	<i>Phoenix Park.</i>	
"	26	<i>Ballycorus.</i>	Golden Ball— <i>Granite</i> .—Here are situated the lead-reducing works of the Mining Company of Ireland: the lead lode is said to be worked out. Native silver found here.— <i>See Native silver.</i>
"	26	<i>Rathmichael.</i>	Golden Ball— <i>Granite</i> .—Lead: said to be worked out.
"	26	<i>Shankhill.</i>	
"	16	<i>Howth.</i>	Vicinity of . . — <i>Cambrian</i> .—Lead: worked out.
"	23	<i>Dalkey.</i>	Kingstown — <i>Granite</i> .—Worked out. Zinc and tin associated with lead ore. In no other place in Ireland, in modern times, has tin, as an ore, been found in a vein.— <i>See Tin list.</i>
"	23	<i>Mount Mapas.</i>	Killiney Hill— <i>Ordovician</i> .—Copper and lead: worked out.
Fermanagh.		<i>Magheramenagh.</i>	Balleek— <i>Carboniferous</i> .—Lead in small quantities: worked about 1872.
Galway.	117	<i>Crannagh.</i>	Tynagh — <i>Carboniferous</i> .—Principally lead. For the works at Carhoon, <i>see Native silver list.</i>
"	107 & 117	<i>Carhoon.</i>	
"	117	<i>Quarry Hill.</i>	
"	113	<i>Ballymaquiff.</i>	Ardrahan— <i>Carboniferous</i> .—The paying portions of the known veins are worked out. Lead associated with copper at Muggaunagh.
"	103	<i>Muggaunagh.</i>	
"	103	<i>Parkalleva.</i>	

COUNTIES.	No. of Ordance Sheet.	LOCALITIES.	REMARKS.
Galway.	128	<i>Caherglassoun.</i>	Gort— <i>Carboniferous</i> .—A rich lode, silver, and silver-lead. A large mass of the latter was exhibited at the Dublin Exhibition, 1851. Unfortunately, on account of the cavernous nature of the limestone, the tide's ebb and flow affect the water of the mine, and prevent the deep ore from being followed.
"	106	Killeely.	Kilcolgan— <i>Carboniferous</i> .—Lead.
"	94	<i>Rineville West.</i>	Oranmore— <i>Carboniferous</i> .—Lead and zinc.
"	94	<i>Cappanaveragh</i> (Lena-boy).	Galway— <i>Granite</i> .—Lead.
"	98	Spiddal West.	Spiddal— <i>Granite</i> .—Lead, copper, and sulphur ore. At Minna there is a fair show of copper.
"	98	<i>Kilros West.</i>	
"	91	<i>Inverin and Minna.</i>	
"	91	Tully.	
"	90	<i>Rossaveel.</i>	Costelloe, or Caahla Bay.— <i>Granite</i> .—
"	90	<i>Derryagh South.</i>	Principally lead; copper at Derryneea and Rossaveel. In the Carrowros promontory, bearing about N.N.E. and S.S.W., is a large reef of quartz that, in places, has a slight mineral staining.
"	90	Boorroughaun.	
"	90	Keeraunbeg.	
"	90	<i>Carrowros south.</i>	
"	78	Clynagh (Crumpaun).	
"	78	<i>Lettermuckee</i> (Carra-sula).	
"	79	<i>Derryneea</i> (Loughaun-weeny).	
"	11	Leenaun (Bonwee).	Leenaun— <i>Silurian</i> .—Lead and silver-lead; also barytes at Griggins.
"	25	Griggins.	
"	36	Derrylea.	Clifden— <i>Metamorphic Cambrian and Ordovician</i> .—At Derrylea there was a large excavation in search of gold, not a particle of which was found.
"	36	Barnanoran.	
"	40	Letterabaak Lough.	
"	50	Roundstone.	Vicinity of . . — <i>Granite</i> .—Lead.
"	54	<i>Cheremount.</i>	Oughterard— <i>Carboniferous</i> .—Lead: principally.
"	54	<i>Thunowree.</i>	
"	54	<i>Ardarua.</i>	
"	54	<i>Illau-na-creeva.</i>	
"	54	Moyroon East.	
"	54	<i>Lemonfield.</i>	
"	54	Righterard.	
"	54	<i>Crogy.</i>	
"	54	<i>Portacarran.</i>	

COUNTIES.	N. of Ordance Sheet.	LOCALITIES.	REMARKS.
Galway.	89	Barnagorteen.	Oughterard— <i>Metamorphic Cambrian and Ordovician, with intrudes of Granite, &c.</i> —Where the rock is limestone or granite the ore is principally lead; but elsewhere lead, copper, zinc, barytes, and sulphur ore occur more or less together. At Glengowla East the gangue in part was crystalline green fluorspar.
"	30	Curraghduff North, Middle and South.	
"	30	Derroura.	
"	30	Barratlova.	
"	54	Rusheeny.	
"	54	Canrawar.	
"	54	Oregg.	
"	54	Clooshgereen.	
"	54	Glengowla East.	
"	64	" West.	
"	55	Corrancliatrum.	
"	68	Gortmore (Wormhole).	Moycullen— <i>Carboniferous.</i> —Principally lead. The Wormhole mine is along-side Lough Corrib, and it is difficult to keep the water down, as there is leakage from the lake.
"	39	Drumsnau (Doon).	
"	89	Carrowgarraff.	Maum Bridge— <i>Metamorphosed Ordovician.</i> —Lead, copper, manganese, and iron.
"	55	Curraghmore.	Headford— <i>Carboniferous.</i> —Lead and sulphur ore.
"	85	Knockroe.	Monivea— <i>Carboniferous.</i> —Lead.
Kerry.	20 & 21	Ardfert.	Vicinity of . . — <i>Carboniferous.</i> —Lead.
"	30	Clogher.	Castleisland — <i>Carboniferous.</i> —Silver, silver-lead, and copper.
"	47	Annagh East.	
"	47	Meanus.	Castlemaine — <i>Carboniferous.</i> —Silver-lead; with zinc at Annagh, and a little copper at Meanus.
"	47	Ballybrack.	
"	9	Ballinglanna.	
"	9	East of Caahen River.	Causeway— <i>Carboniferous.</i> —Lead; with a little copper on the coast to the east of Caahen River.
"	15 & 16	Lixnaw.	
"	93	Caher West, or Shanagarry.	Kenmare — <i>Carboniferous.</i> —Lead. At Shanagarry, a sub-division of Caher West, silver-lead and copper are associated.
"	93	Killowen.	
"	93	Public Garden.	
"	66	Cahernane.	
"	66	Ross Island.	Killarney— <i>Carboniferous.</i> —Silver-lead at Cahernane. Lead, zinc, and copper at Ross Island.
"	29	Ballybeggan.	
"	29	Ballymullen.	Tralee — <i>Carboniferous.</i> —At Oakpark only lead is recorded; at the others copper was associated with silver-lead. Native silver at Lismoolleen.
"	20	Lismoolleen.	
"	29	Oakpark.	
Kildare.	15	Ardclough.	
"	15	Wheatfield Upper.	Celbridge— <i>Carboniferous.</i> —Lead; with some zinc at Wheatfield.

COUNTIES.	No. of Ordinary Sheet.	LOCALITIES.	REMARKS.
Kildare.	3	Freagh.	Edenderry — <i>Carboniferous</i> . — Lead : worked out.
Kilkenny.	33	Ballygallon.	Inistioge — <i>Carboniferous</i> . — Silver-lead.
"	48	Dunkitt.	Kilmacow — <i>Carboniferous</i> . — Lead.
"	27	Knockadrina (Flood Hall).	Knocktopher — <i>Carboniferous</i> . — Silver and silver-lead ; a very ancient mine. <i>See Native silver list.</i>
King's Co.	12	Monasteroris (Blundell Mines).	Edenderry — <i>Carboniferous</i> . — Lead : worked out.
"	36 &c.	Slieve Bloom.	Kinnity — In the <i>Ordovician</i> rocks of Slieve Bloom, lead and copper have been recorded in several places, but whether together or separate is not mentioned.
Leitrim.	11	Barrackpark.	Lurganboy — <i>Carboniferous</i> . — Silver-
"	7	Twispark.	lead in dolomitic sand.
Limerick.	11	Ballycanauna, or Bally- steen.	Askeaton — <i>Carboniferous</i> . — Lead ; with some zinc and pyrites at Graigue :
"	23	Graiguelough.	at Ballysteen there was silver-lead
"	11	Askeaton.	and silver. The known deposits in
"	23	Kilcolman.	these places, except Askeaton, worked out.
"	3	Ballydooles.	Pallaskenry — <i>Carboniferous</i> . — Copper and silver-lead.
"	20	Ardgoul South.	Bathkeale — <i>Carboniferous</i> . — At Ardgoul
"	20	Freagh.	— discovered when making the rail-
"	20	Booaglass.	way — there is a good show of silver-
"	20	Ballingarrane.	lead. Freagh and Booaglass un-
"	20	Cloghatrida.	proved. The other places, where
"	20	Ballineirick.	there was silver-lead, zinc, copper, and pyrites, are worked out.
"	36	Mahoonagh.	Newcastle — <i>Carboniferous</i> . — Lead : worked out.
"	25	Tower Hill.	Pallasgreen — <i>Carboniferous</i> . — Lead.

COUNTIES.	No. of Ore Specimens.	LOCALITIES.	REMARKS.
Limerick.	25	<i>Oola Hill.</i>	<i>Oola</i> — <i>Carboniferous</i> .—Silver-lead, carbonate of lead, copper, and barytes.
"	25	Carrigbeg, or Coonagh Castle.	Doon— <i>Carboniferous</i> .—Lead.
Londonderry.	25	Scrigan.	Dungiven — <i>Carboniferous</i> .—Tumblers and fragments of lead (<i>galenite</i>).
Longford.	14	Longford.	Two miles E.S.E. of . . — <i>Carboniferous</i> .—Silver-lead.
Louth.	23 & 94	Oldbridge.	Drogheda— <i>Ordovician</i> .—Lead and copper.
"	7	Crumlin.	Dundalk— <i>Ordovician</i> .—Lead. At Fair-
"	7	<i>Fairhill.</i>	hill tumblers were found in the trials made.
"	16	<i>Salterstown.</i>	Togher— <i>Ordovician</i> .—Lead and copper.
Mayo.	106	Ballynastockagh, or Bellaveel.	Ballyhaunis— <i>Carboniferous</i> .—Lead.
"	75	<i>Bolinglana.</i>	Newport — <i>Carboniferous</i> .—Silver-lead,
"	65	<i>Brahmore.</i>	copper, and pyrites.
"	107	<i>Tawneycrosser</i> (Sheefry).	Westport— <i>Ordovician</i> .—Silver-lead.
"	121	Ballymacgibbon.	Headford — <i>Carboniferous</i> .—Lead and
"	121	Gortbrack.	pyrites.
Meath.	23	<i>Cloghan.</i>	Ardcath— <i>Ordovician</i> .—Lead; very ancient mine.—(<i>Griffith</i> .)
"	29 & 25	<i>Athboy.</i>	South of . . — <i>Carboniferous</i> .—Lead.
"	26	Dollardstown.	Slane (Beaupark mine)— <i>Carboniferous</i> .—Lead and copper.
Monaghan.	19 & 24	Corbrack.	Ballyboy — <i>Ordovician</i> .—Principally lead.
"	19	Cornamucklagh North.	
"	19	" South.	
"	19	<i>Dernaclug.</i>	
"	14	<i>Derrylish.</i>	
"	24	<i>Sra.</i>	
"	3	<i>Derryledigan-Jackson.</i>	Bellanode — <i>Carboniferous</i> .—Lead and zinc.
"	25	<i>Cornalough.</i>	Castleblayney— <i>Ordovician</i> .—Lead, or
"	25	<i>Cloggan.</i>	silver-lead; barytes at the first two.
"	25	<i>Carrickagarran.</i>	The deposits are supposed to be
"	25	<i>Dromore.</i>	worked out.

COUNTIES.	No. of Ordance Sheet.	LOCALITIES.	REMARKS.
Monaghan.	15	<i>Annaglogh.</i>	Monaghan— <i>Ordovician</i> .—Lead is the principal ore at these localities; it being associated with zinc at Avalreagh, Kilcrow, and Coolartagh. barytes also occurring at the latter, At Lisglassan and Tullybuck it was accompanied by antimony ore. At most of the places printed in italics the paying portions of the veins were taken out.
"	19	<i>Annayalla.</i>	
"	14	<i>Avalbane.</i>	
"	14	<i>Avalreagh.</i>	
"	14	<i>Carrickaderry.</i>	
"	14	<i>Carrickanure.</i>	
"	14	<i>Clareoghill.</i>	
"	14	<i>Coolartagh.</i>	
"	14	<i>Cornamucklagh North.</i>	
"	14	<i>Croaghan.</i>	
"	14	<i>Crossmore.</i>	
"	14	<i>Glassdrumman East.</i>	
"	14	<i>Grig.</i>	
"	14	<i>Kilcrow.</i>	
"	14	<i>Latnakelly.</i>	
"	14	<i>Lengere.</i>	
"	15	<i>Lisdrumgormly.</i>	
"	14	<i>Lisglassan.</i>	
"	14	<i>Tassan.</i>	
"	14	<i>Tonnagh.</i>	
"	14	<i>Tullybuck.</i>	
Queen's Co.	18	<i>Dysart.</i>	Maryborough— <i>Carboniferous</i> .—Lead.
"	23	<i>Coolbaun.</i>	Ballickmoyler— <i>Carboniferous</i> .—Lead.
"	23	<i>Ballickmoyler.</i>	
Roscommon.		—	—
Sligo.	20	<i>Abbeystown.</i>	Ballysadare— <i>Carboniferous</i> and <i>Cambrrian</i> .(?)—Lead. Native silver at the first: the old deposits in both places worked out. New veins since discovered.
"	20	<i>Lugacarry.</i>	
"	6 & 9	<i>Glencarbury.</i>	King's Mountain, Sligo— <i>Carboniferous</i> .—Lead, copper, and barytes. The deposit at Glencarbury is principally barytes.
"	9	<i>Tormore.</i> <i>Seafield</i> (Knocknarea),	
Tipperary.	23	<i>Garrane.</i>	Toomavara — <i>Carboniferous</i> . — Locally called the "Silver mine;" supposed to be the Rosargid of the "Annals." — <i>See Native silver list.</i>
"			Portroe — <i>Ordovician</i> .—Lead. Garry-kennedy was a very ancient mine, stone and wood implements, &c., having been found in the "Old Men's Workings."
"			
"			
"	19	<i>Corbally.</i>	
"	13	<i>Garrykennedy.</i>	
"	19	<i>Laghtea.</i>	

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Tipperary.	33 & 34	Cooleen.	Borrisoleigh— <i>Ordovician</i> .—Lead.
"	36	Ballygowan.	Silvermines, near Nenagh— <i>Carboniferous</i> (sandstone and limestone).—These are all sub-denominations of the great "SILVERMINE SETT." In these mines have been found silver, silver-lead, lead, silver-copper, copper, zinc, and pyrites. They were worked in prehistoric times, and the attals in the old stulls have lain so long that, by chemical change, new minerals have formed. The fault at Silvermines, on which the lodes are situated, can be traced eastward to Toomavara, and westward to Gallowahill, near Sixmilebridge, Co. Clare.
"	36	Cleonanagh.	
"	36	Cooleen.	
"	36	Garryard East and West.	
"	36	Gortemadiha, or Gort-nadyns.	
"	36	Gortsheneros, or Ballynos.	
"	36	Knockanroo.	
"	36	Lacks.	
"	36	Shallee East and West.	
"	74	Aherlow Vale.	Tipperary— <i>Carboniferous</i> .—Silver-lead, copper, and manganese.
Tyrone.	18(?)	Crockanboy.	Gortin— <i>Ordovician</i> .(?)—Lead; worked in 1864.
"	18(?)	Treban West.	
Waterford.	94	Ballydowans.	Bunmahon— <i>Ordovician</i> .—These are portions of "BUNMAHON COPPER MINES." At both places there was silver-lead associated with copper; while at Knockmahon zinc and cobalt were also found.— <i>See Copper list</i> .
"	28	Knockmahon.	
"	7	Monminane.	Carrick-on-Suir— <i>Ordovician</i> .(?)—Lead.
"	17	Cruch.	Tramore— <i>Ordovician</i> .—An ancient lead mine.
"	26	Mine Head.	Ardmore— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Silver-lead.
"	40	Monatray.	Coast opposite Youghal— <i>Carboniferous</i> .(?)—Lead.
"	29	Camphire.	Lismore— <i>Carboniferous</i> .—Silver-lead; worked about the year 1825.
Westmeath.	—	—	Traces of lead found in different places.

COUNTIES.	No. of Ordinary Sheet.	LOCALITIES.	REMARKS.
Wexford.	45	Clonmines.	Carrick-on-Bannow.— <i>Ordovician</i> .—At Clonmines there is the <i>debris</i> of very ancient mines, supposed to have been worked by the Ostmen. Here in Charles I.'s time there was a mint. At Barrystown there were workings on a lode containing silver-lead and zinc.
"	45	Barrystown.	
"	46	Gibberpatrick.	Duncormick — <i>Carboniferous</i> . — Lead; veins of dolomite sand with strings of lead.
"	43	Killian.	Wexford — <i>Carboniferous</i> . — Lead and barytes veins cut in the canal at the South Slob. Strings of lead found when sinking the well at Bishops-water Distillery.
"	43	South Slob, intake.	
"	37	Bishopswater.	
"	19	Aughathlappa.	Enniscorthy — <i>Ordovician</i> . — Lead, or silver-lead. At Caim there were also some zinc, copper, iron, and sulphur ore. The profitable portion of the veins are supposed to be worked out.
"	19	Caim.	
"	19	Killoughrum.	
"	19	Mangan.	
Wicklow.	12	Douce Mountain.	Enniskerry— <i>Granite and Mica-schist</i> . —Lead and copper.
"	&c. 7	Powerscourt.	
"	&c. 9	Glen of	Hollywood— <i>Metamorphic Ordovician</i> .—Lead.
"	12	Lough Tay.	Togher, or Roundwood— <i>Granite</i> —Lead, with at Lough Dan copper and zinc. At Carrigeenduff, Lough Dan, the vein worked out.
"	17	Lough Dan.	
"	27	Boylelug, or Moatamoy.	Baltinglass— <i>Granite</i> , or <i>Mica-schist</i> .—Lead.
"	43	Shillelagh.	Vicinity of . . — <i>Granite</i> .—Lead.
"	38	Carrigroe.	Tinahely— <i>Granite</i> .—Lead. An ancient mine.
"	17	Brockagh.	GLENDALOUGH LEAD MINES.— <i>Granite and Mica-schist</i> . — Luganure and Glendassan are sub-denominations of Brockagh. Lead, silver-lead, zinc, iron, a little copper, &c.
"	23	Lugduff.	
"	17 &	Camaderry.	
"	23		

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Wicklow.	22	Lugnaquilla (North Prison).	Rathdrum, GLENMALURE MINES— <i>Granite</i> —Extending in places into the <i>mica-schist</i> . All are in Glenmalure, the valley of the Avonbeg. In many places with the lead there are zinc and copper. At Baravore there is superior barytes, and at Clonkeen iron and zinc. At the North Prison, Lugnaquilla, there is a promising-looking lode, but the place is very inaccessible.
"	23	Ballinafunshoge.	
"	22 & 23	Ballinagoneen.	
"	23	Ballyboy.	
"	23	Baravore.	
"	22	Camenabologue.	
"	23	Clonkeen.	
"	22	Clonvalla.	
"	23	Corrasillagh.	
"	23	Cullentragh Park.	
"	35	Ballinaclash.	
"	28	Aghavannagh.	Aughrim— <i>Granite</i> .—Lead and copper.
"	40	Ballintemple.	Woodenbridge — <i>Metamorphic Ordovician</i> .—Lead. At Clonwilliam only strings have been found.
"	40	Clonwilliam.	
"	35	Shroughmore.	OVOCA — <i>Metamorphic Ordovician</i> .—These belong to the EAST OVOCA MINES. In all of them the lead is more or less associated with copper and pyrites. Native silver (auriferous) has been found in east Cronebane (Magpie), Connary, and Kilmacoo; also the peculiar mineral called Kilmacooite, or "Bluestone," which is a mixture of the sulphides of copper, lead, zinc, iron, antimony, arsenic, and silver, with a trace of gold.
"	35	Kilmacoo.	
"	35	Connary.	
"	35	Cronebane.	
"	35	Kilmacrea.	Redcross — <i>Metamorphic Ordovician</i> .—Zinc and lead.

COPPER.

[Copper is recorded as having been found native in the mines at East Cronebane and Connary in cracks or slight shrinkage fissures in the veins, while the mine water has deposited it on the metals in the old working. Native copper, sometimes in geodes, was found at Kilduane, Bonmahon, Co. Waterford, and sparingly in some of the lodes in S.W. Cork. Yellow copper ore (*chalcopyrite*) is often found associated with lead in the limestones of Carboniferous age, but usually in too small quantities to be of any value. In the sandstones, whether high up or at the base (*Lower Carboniferous sandstone*), the copper usually predominates. In the Devonian rocks it principally occurs as the yellow ore (*chalcopyrite*), and grey ore (*tetrahedrite*); and on the backs (*gossan lodes*) of some of the lodes, the carbonates (*malachite* and *azurites*), and oxide (*melanconite*). Generally it is only associated with sulphur ore or mundic (*pyrite*); but sometimes lead (*galenite*) and barytes (*barite*) are present; the latter in places being so mixed as to deteriorate or ruin the ore. The ores are most prevalent in the *Metallic Shales*, or the upper zone of the Devonians. In the unaltered Silurians, Ordovicians, and Cambrians, also in the granite, the yellow ore, similarly as in the Carboniferous, usually occurs associated with the lead ores; but only in small quantities; while in the metamorphic rocks it is in larger quantities; sometimes being independent, but more often associated with pyrites, lead, zinc, or barytes. Some of the pyrite or sulphur ore at Ovoca was a poor ore of copper containing from 2 or 3 to 8 or 10 units; and the copper in the ash of such ores, after the sulphur is abstracted, is found to be remunerative.

At Carrigacat and Kilerohane, Co. Cork, and Ballymurtagh, Co. Wicklow, the copper ore (*coppery pyrite*) is in part auriferous, while most of the old coppery lodes in the great Ovoca channel probably contained some gold. At Garryard, Gortnadayne, and Gortshaneroe, Co. Tipperary, and near Bantry, Co. Cork, the copper ores are argentiferous.]

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Armagh.	31	Tullydonnell.	Crossmaglen—Ordovician.
"	22	Kilmonaghan (<i>Gerrard's</i> , or <i>Tuscan Pass</i>).	Newry—Ordovician.
Carlow.	24 & 26	Carricklead Mountain.	Graiguenamanagh—Granite. (P)
Cavan.	20	Farnham Demesne.	Cavan—Carboniferous.
Clare.	6	Cappagh.	Ballyvaughan—Carboniferous.—In
"	6	Glenulla.	small quantities with lead.
"	9	Lisnannroum.	
"	20	Corrakyle.	Feakle—Ordovician.
"	20	Leaghort.	
"	34	Ballyhickey.	Quin—Carboniferous.—In small quantities with lead and zinc.
"	26	Ballyvergin.	Tulla—Carboniferous.—With lead and pyrites.
"	36 & 44	Shannaknock.	Broadford—Ordovician.—With pyrites.

COUNTIES.	No. of Copper Shots.	LOCALITIES.	REMARKS.
Cork.	114	<i>Allihies.</i>	BEARHAVEN MINES— <i>Devonian</i> .—Yellow copper ore; with a large pocket of the carbonates in the north mine. The veins both horizontally and in depth seem to have passed out of the "metallic shales," (upper zone of the Devonians) and to have become unprofitable.
"	187	<i>Cahermoolbeg.</i>	
"	114	<i>Caminches.</i>	
"	114	<i>Cloan.</i>	
"	114	<i>Coom.</i>	
"	114	<i>Kealeys.</i>	
"	& 187		
"	116	Killaconenagh.	Bearhaven— <i>Devonian</i> .—With lead.
"	&c. 90	<i>Bak Mountain.</i>	Glengariff— <i>Devonian</i> .
"	129	<i>Carravilleen.</i>	Bantry— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—At Derreengreanagh associated with barytes. At Lissaremig and Rooska grey argentiferous ore, with silver-lead, arsenic, and iron (<i>chalybite</i>).
"	130	<i>Clashadoo, or Four-mile Water.</i>	
"	117	<i>Lissaremig.</i>	
"	117	<i>Rooska.</i>	
"	118	<i>Derreengreanagh.</i>	
"	129	<i>Glanalin.</i>	
"	138	<i>Gortavallig.</i>	
"	118	<i>Hollyhill.</i>	
"	129	<i>Killoen, North.</i>	KILCROHANE MINES (Sheep Head)— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—A large lode of sulphur-ore, with strings or thin veins of yellow copper. Along the bedding are beds containing grey copper (argentiferous and auriferous(?)), and on the back of the lodes and beds, carbonates and oxides of copper. Worked by the South Bearhaven Co. At Kilcrohane there is a thick sulphur-ore (<i>mundic</i>) lode.
"	129	" <i>South.</i>	
"	129	<i>Knockree.</i>	
"	129	<i>Kilcrohane.</i>	
"	140	<i>Ballycummiak.</i>	Ballydehob— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—BALLYDEHOB AND AUDLEY MINES. There are different lodes in each sett, some with grey ore, others with yellow. Some of the yellow ore lodes are good, others more or less deteriorated with barytes. Lead is sometimes also found in small quantities, as at Ballycummiak, and in the gossan, at Horse Island. Skeaghannore is a peculiar name, as if gold was once found there.
"	140	<i>Cappaghglass.</i>	
"	140	<i>Foinamuck.</i>	
"	149	<i>Horse Island.</i>	
"	140	<i>Rossbrin.</i>	
"	140	<i>Ballydehob.</i>	
"	140	<i>Bolough.</i>	
"	140	<i>Cooragurteen.</i>	
"	140	<i>Kilcoo.</i>	
"	140	<i>Skeaghannore.</i>	
"	181	<i>Derroonnamane.</i>	
"			
"	140	<i>Kilbilleen.</i>	Ballydehob— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—ROARING WATER MINES. Copper and lead.
"	140	<i>Laheratanally.</i>	
"	149	<i>Leigholeen.</i>	

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Cork.	148	Castlepoint.	SKULL MINES— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Generally more than one lode in each sett. Principal ores the yellow and grey ! but at Coosheen there was a back of carbonates and iron. At Mount Gabriel there is also barytes.
"	149	Castleisland.	
"	139	Coosheen.	
"	&		
"	144		
"	140	Gortnamona.	
"	148	Longisland.	
"	148	Skull.	
"	148	Leamcon.	
"	139	Mount Gabriel.	
"	148	Altar.	CROOKHAVEN MINES— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Yellow and grey ores. In some setts more than one lode. At Carrigacat the gossan was auriferous, at Boulysallagh there were silver and lead, and at Spanish Cove silver-lead. At Balteen a quartz lode was worked for gold, although no gold had ever been detected in it.
"	147	Ballydivlin.	
"	147	Ballyrisode.	
"	147	Balteen.	
"	147	Carrigacat, or Dhurode.	
"	147	Boulysallagh,	
"	147	Callaros.	
"	146	Cloghane (Mizzen Head).	
"	147	Crookhaven.	
"	147	Kilbarry.	
"	152	Mullavoge (Brow Head).	SKIBBEREEN— <i>Yellow Sandstone</i> , or <i>Devonian</i> . Castletownsend— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Also lead and antimony. Roscarberry—(GLANDORE MINES) <i>Yellow Sandstone</i> , or <i>Devonian</i> .—At Aughtabrid there is a back of iron and manganese that extends eastward to Roury Glen and Roscarberry (<i>see list, Iron ores</i>). At Little Island there is barytes.
"	147	Kilmore (Spanish Cove).	
"	147	Lackavaun.	
"	148	Toormore.	
"	151	Bawnishall.	
"	142	Rabbit Island.	
"	142	Aughtabrid.	
"	142	Derry.	
"	142	Drom.	
"	142	Keamore.	
"	142	Kilfinnan.	CLONAKILTY— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Also lead and barytes: the mine worked principally for the latter. Dunmanway — <i>Devonian</i> , or <i>Yellow Sandstone</i> . Youghal— <i>Devonian</i> , or <i>Yellow Sandstone</i> .—At the Fever Hospital there is a strong coppery-looking spa. Cork— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Yellow ore, with a little carbonate. Vicinity of . . . — <i>Devonian</i> . (?)
"	142	Gortagrenane.	
"	142	Little Island.	
"	144	Duneeen.	
"	107	Derreens.	
"	107	Coom.	
"	107	Inchanadreen.	
"	78	Knockadoon.	
"	78	Capel Island.	
"	67	Fever Hospital.	
"	63 & 74	Rathpeacan.	
"	88	Millstreet.	

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Donegal.	106	Bundoran.	Vicinity of . . — <i>Carboniferous</i> . — Also lead.
"	107	<i>Abbeystland.</i>	Ballyahannon — <i>Carboniferous</i> . — With lead and zinc : worked for the lead ore.
"	107	<i>Abbeystlands.</i>	
"	107	<i>Finner.</i>	
"	28	Salt pans.	Rathmullen — <i>Ordovician</i> . — Thin vein yellow ore ; a quartz lode, to the northward, coppery.
"	53 & 61	Scrably and Carrygally.	South of Letterkenny — <i>Cambrian</i> . (P) — A copper-stained quartz lode, with N.E. and S.W. line of coppery spas.
"	4, &c.	Clonea.	Carndonagh — <i>Ordovician</i> . (P)
"	36	Cashleenan.	Kilmacrenan — <i>Ordovician</i> . (P)
"	15	<i>Marfagh.</i>	Dunfanaghy — <i>Cambrian</i> . (P) — Also lead, pyrites, and iron : worked for the lead principally.
"	17	Fanad.	Glinak — <i>Ordovician</i> . (P) — Also lead.
"	64, &c.	Iniskeel.	Naran — <i>Ordovician</i> . (?) — Also lead.
Down.	53	Glassdrumman.	Annalong — <i>Ordovician</i> . — Also lead.
"	39	Gun's Island.	Ardglass — <i>Ordovician</i> . — Also lead and barytes.
"	53 &c.	<i>Mourne Mountains.</i>	Kilkeel — <i>Granite</i> and <i>Ordovician</i> . — Also lead.
"	45	St. John's Point.	Killough — <i>Ordovician</i> . — Also pyrites.
"	31	<i>Tullyratty.</i>	Strangford — <i>Ordovician</i> . — Also lead.
Dublin.	28	Seapoint.	Blackrock — <i>Granite</i> . — Traces.
"	12	Malahide.	Vicinity of . . — <i>Carboniferous</i> .
"	9	Lambay.	Skerries — <i>Ordovician</i> . — Also iron.
"	5	<i>Loughshinny.</i>	Rush — <i>Carboniferous</i> .
Fermanagh.	9	<i>Rossbeg, or Castle Caldwell.</i>	Belleek — <i>Carboniferous</i> . (?) — Also iron. NOTE. — At Magheramenagh, between Castle Caldwell and Belleek, copper was raised by the late Mr. Johnston in the <i>Carboniferous</i> limestone.
Galway.	91	<i>Inverrin and Minna.</i>	Spiddal — <i>Granite</i> , or <i>allied rocks</i> . — Ores very mixed ; lead and pyrites usually present : which, in general, are more abundant than the copper.
"	79	<i>Derrynea.</i>	
"	90	<i>Rossaveel.</i>	
"	90	<i>Maumeen</i> (Gorumna Island).	
"	90	Teeranea.	

COUNTIES.	No. of Ordance Sheet	LOCALITIES.	REMARKS.
Galway.	54	Bunnagippaun.	Oughterard— <i>Metamorphic Cambrians</i> , or <i>Ordovician</i> .—Lead, pyrites, or pyrrhotite, are generally present; sometimes zinc and barytes. If the lode is in limestone, as at Glengowla, the ore is principally lead. In the Curraghduffs there were good bunches of yellow copper ore.
"	54	Canrower.	
"	54	Creggs.	
"	54	Clooshgeroon.	
"	54	Glengowla West.	
"	39	Barratleva.	
"	39	Derroua.	
"	39	Curraghduff— <i>West</i> , <i>Middle</i> , and <i>South</i> .	
"	39	Derreenagusfoor.	
"	39	Curraunbeg.	
"	39	Shannawagh.	
"	39	Derroua.	
"	40	Gorteenwalla.	
"	40	Ballygally.	
"	39	Drumsnavo.	Maum Bridge— <i>Metamorphic Cambrian</i> . —At Drumsnavo there were also lead, manganese, and iron; while at Maumwee the ore was princi- pally pyrrhotite.
"	39	Maumwee.	
"	11	Leenaun (Benwee).	Leenaun Hotel— <i>Silurian</i> .—Principally lead.
"	49	Ballyconneely.	Roundstone— <i>Metamorphic Ordovician</i> , <i>Granite</i> , &c.
"	50	Tallaghllummanmore.	
"	63	Murvey.	
"	63	Dogs Bay.	
"	63	Errisbeg, West and East.	
"	9	Cleggan Tower.	Clifden— <i>Metamorphic Ordovician</i> , or <i>Cambrian</i> .—In the <i>Rinivyle district</i> , <i>Dawrosmore</i> (sheets 10 and 23), <i>Cloon-</i> <i>looaun</i> (9 and 10), <i>Cashleen</i> (9), &c., trials have been made in search for copper and iron, but not with good result. This tract lies to the N.W. of Kylemore Lake.
"	9	Tullymore.	
"	21	High Island.	
"	23	Cloon (Cleggan Mine).	
"	23	Boolard.	
"	23	Doon.	
"	23	Doosen.	
"	35	Arábear.	
"	35	Fakeeragh.	
"	24	Kylemore and Gleni- nagh.	Recess— <i>Metamorphic Cambrian</i> .(?)— Also sulphur ore.
"	36	Barnanoran.	
Kerry.	30	Clogher.	Castleisland— <i>Carboniferous</i> .—With sil- ver and lead: worked for the lead.
"	47	Meanus.	Castlemaine— <i>Carboniferous</i> .—With lead: worked for the latter.
"	9&c.	Coast east of Cashen River.	Causeway— <i>Carboniferous</i> .—With lead.
"	52	Dunquin.	Vicinity of . .

COUNTIES.	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000	LOCALITIES.	REMARKS.
Kerry.	93	Greenlane.	Kenmare—Carboniferous and Devonian.
"	93	Cromwell's Fort.	—With silver-lead at Caher West.
"	93 & 103	Muckross.	
"	93	Ardilly (Clontoo).	
"	93	Caher West (Shannagarry).	
"	93	Caher East.	
"	94 & 93	Gortnacurra.	
"	93	Kenmare, west of.	
"	74	Muckross.	Killarney—Carboniferous.—Very ancient mines. Cobalt and sulphur ore at Muckross; lead and zinc at Ross Island: the latter worked principally for lead. Mines mentioned by Nennius, a ninth century writer.
"	93	Ross Island.	
"	106	Garraugh.	Sneem—Yellow Sandstone, or Devonian.
"	90	Staigus.	
"	29	Ballybeggan.	Tralee—Carboniferous.—Principally lead. At Lissoleen there is native silver.
"	29	Ballymullen.	
"	90	Lissoleen.	
"	78 & 87	Finnies Upper.	Cahersiveen—Devonian, or Silurian.
"	87	Oughquick.	
"	87	Clynacartan.	
"	79	Garranearagh.	
"	106	St. Crehan, or Behaghane.	Westcove—Devonian.(?)
Kildare.	17	Punchersgrange.	Newbridge—Ordovician.
"	23	Dunmurray.	Kildare—Ordovician.
Kilkenny.	31	Knocktopher.	Vicinity of . . —Carboniferous.
King's Co.		Monasteroris.	Killan, on Grand Canal.—Carboniferous.
"	36 &c.	Slieve Bloom.	Kinnity—Carboniferous Sandstone, and Ordovician.
Leitrim.		Skreeny.	Manorhamilton—Metamorphic Cambrian.(?)
"	11	Gortnashough.	Lurganboy—Metamorphic rocks; Cambrian.(?)
"	11	Pollboy.	
"	11	Shanass.	
Limerick.	8	Ballydoole.	Pallaskenry—Carboniferous.—The mine at Ballydoole was worked for lead.
"	8	Charter School.	

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Limerick.	20	Ballingarrane.	Rathkeale— <i>Carboniferous</i> .—Also silver-
„	20	Cloghatrida.	lead, zinc, and sulphur ore. The deposits, which were wrought for the lead, worked out.
„	25	Oola Hill.	Oola— <i>Carboniferous</i> .—Also lead, zinc, and sulphur ore: the lead in excess.
Louth.	22	Clogher.	Drogheda— <i>Ordovician</i> .—Also lead at
„	23 & 24	Oldbridge, West of.	Oldbridge.
„	16	Salterstown.	Togher— <i>Ordovician</i> .—Also lead: seems to have been principally worked for the latter.
Mayo.	6	Ballydergmore.	Ballycastle— <i>Carboniferous</i> .
„	5	Geevraun.	
„	7	Doonadoba.	Seacoast N.E. of Ballycastle.— <i>Car-</i> <i>boniferous</i> .
„	86	Louisburgh.	Vicinity of . . — <i>Silurian</i> .—Also sul- phur ore.
„	114	Bofin Island.	Cleggan — <i>Ordovician</i> . — Also sulphur ore.
„	75	Bolinglana.	Molrany, CORRAUN MINES. — <i>Ordovi-</i>
„	65	Srahmore.	<i>cian</i> .(?)
Meath.	26	Dollardstown.	Slane, BEAUPARK MINES— <i>Carbonife-</i>
„	26	Painstown.	<i>rous</i> .—Also a little lead.
„	32	Brownstown.	Walterstown— <i>Carboniferous</i> .—Worked
„	32	Cusackstown.	in 1800: veins said to be worked
„	32	Kentstown.	out.
Roscommon.	—	—	—
Sligo.	6 & 9	Glencarbury.	Sligo (King's Mountain)— <i>Carboniferous</i> .
„	9	Tormore.	—Also lead; but principally barytes.
Tipperary.	33	Gortnahalla.	Borrisoleigh (Clodiagh Valley)— <i>Ordovi-</i> <i>cian</i> .—An ancient mine.
„	38	Lackamore.	Newport— <i>Ordovician</i> .—At Lackamore
„	38	Toorenbrien Upper.	ancient tools were found in the “old mens’” workings.
„	19	Derry Demesne.	Portroe— <i>Ordovician</i> .

COUNTIES.	No. of Ordovician Sheet.	LOCALITIES.	REMARKS.
Tipperary.	17	<i>Bathnascoge.</i>	Dunkerrin— <i>Carboniferous.</i>
"	23	<i>Coolruntha.</i>	SILVERMINES, Nenagh— <i>Carboniferous.</i>
"	26	<i>Garryard East.</i>	—Principally in the sandstone. At
"	26	" <i>West.</i>	the Garryards, Gorteenadiha, and
"	26	<i>Gorteenadiha.</i>	Gortahaneroe there was silver-lead;
"	26	<i>Gortahaneroe.</i>	the copper being also argentiferous.
"	26	<i>Knockanroe.</i>	At Knockanroe and Shallee there was
"	26	<i>Shallee East.</i>	also lead, &c.— <i>See Lead list.</i>
"	26	" <i>West.</i>	
"	31 &	<i>Ballyhourigan.</i>	
"	33		
"	74	<i>Aherlow Vale.</i>	Tipperary — <i>Carboniferous.</i> —Also lead
"			and manganese.
"	45	<i>Clonmurragha.</i>	Cappawhite— <i>Ordovician.</i> —
"	45	<i>Gleemough Upper.</i>	
"	45	<i>Lackenacraena.</i>	
"	45	<i>Reefadda.</i>	
"	45	<i>Ballycohen, or Holly-</i>	
"		<i>ford.</i>	
Tyrone.	37	<i>Sluggan.</i>	Pomeroy— <i>Silurian, or Devonian (?)</i> —
"	44	<i>Ballintrain.</i>	Old working at the southern bound-
"	45	<i>Crannogue and Knock-</i>	ary of Crannogue; spas at the
"		<i>naclogh.</i>	northern boundary. Coppery gossan
"	45	<i>Glenbeg.</i>	at Shanmaghry and Lurganeden:
"	45	<i>Aghafad.</i>	more or less coppery spas in the
"	45	<i>Shanmaghry.</i>	other townlands. This country is as
"	45	<i>Lurganeden.</i>	yet unexplored.
			NOTE.—These Tyrone rocks may in part
			be the representatives of the English
			<i>Lower Devonian.</i>
Waterford.	25	<i>Knockane</i>	Annestown— <i>Ordovician.</i>
"	25	<i>Woodstown.</i>	
"	25	<i>Ballydowane.</i>	BONMAHON MINES— <i>Ordovician.</i> —Mi-
"	25	<i>Ballynagigla.</i>	ning in operation at an early age, as in
"	24	<i>Ballynarrid.</i>	some of the old working at the Stage
"	24 &	<i>Ballynasissale.</i>	lode, Knockmahon, rude stone and
"	25		wooden implements were found. In
"	25	<i>Kilduane.</i>	this lode there were also silver-lead,
"	25	<i>Kilmurrin.</i>	zinc, and cobalt; at Ballydowane
"	25	<i>Knockmahon.</i>	silver-lead, and at Kilduane native
"	25	<i>Tankardstown.</i>	copper.— <i>See Cobalt list.</i>
"	24	<i>Templeyrick.</i>	
"	24	<i>Seafeld.</i>	
"	13	<i>Carrigroe.</i>	Ballynamult — <i>Silurian (?) or Devo-</i>
"	5	<i>Knockatrellene, or Bally-</i>	<i>nian (?)</i>
"		<i>macarbery.</i>	
"	33	<i>Killelton (Lady's Cove).</i>	Stradbally— <i>Ordovician.</i>
"	24	<i>Kilminnin.</i>	

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Waterford.	17	Ballykinsella.	Tramore— <i>Ordovician</i> .
Westmeath.	—	—	Traces of copper and lead in places. (<i>Lewis</i> .)
Wexford.	46	St. Tenants.	Duncormick— <i>Carboniferous Sandstone</i> .
"	41 & 42	Forth Mountain.	Wexford— <i>Cambrian</i> .—Also sulphure.
"	42	Kerlogue.	Wexford— <i>Carboniferous</i> .—Malachite.
"	19	Csinn.	Enniscorthy— <i>Ordovician</i> .—Silver-lead, zinc, iron, and sulphur ore: worked for the lead.
Wicklow.	8	Bray Head.	Bray— <i>Cambrian</i> .
"	12 &c.	<i>Douce Mountain.</i> <i>Powerscourt.</i>	Enniskerry—Near the junction of <i>Granite</i> and <i>Mica schist</i> (<i>Ordovician</i>).—Lead also.
"	7 &c.		
"	12	<i>Lough Tay.</i>	Togher, or Roundwood—Junction of <i>Granite</i> and <i>Mica schist</i> .—With lead and zinc.
"	17	<i>Lough Dan.</i>	
"	25	<i>Ashford.</i>	Ballinallea— <i>Ordovician</i> .
"	25	<i>Ballymacahara.</i>	
"	22 & 23	<i>Glenmalur Mines.</i>	Rathdrum—Junction of <i>Granite</i> and <i>Mica schist</i> —In the lead mines a little copper occurred at Ballinagoneen, Camenabologue, and Ballinacarrig, Lower.— <i>See Lead List</i> .
"	23	<i>Aghavannagh.</i>	Aughrim— <i>Metamorphic Ordovician</i> (?)
"	24	<i>Aughrim, Lower.</i>	Ancient mine at Moneyteigue.
"	29	<i>Moneyteigue.</i>	
"	33	Tinnahely.	North of . . .— <i>Ordovician</i> .—Iron ochre and malachite.
"	30	<i>Ballinagore.</i>	Woodenbridge, CARYSPORT MINES—
"	39	<i>Ballinvalley.</i>	<i>Metamorphic Ordovician</i> .—With iron and sulphur ore.
"	39	<i>Ballyvaug.</i>	
"	36	<i>Ballinasillego.</i>	
"	49	<i>Knocknamohill.</i>	SOUTHWEST OVOC, or KNOCKNAMOHILL, MINES— <i>Metamorphic Ordovician</i> .—Old mines worked for iron: the copper and sulphur ore worked a little. The prospects at Killough are bad; also those in the north portion of Ballymoreen.
"	35 & 40	<i>Ballinapark.</i>	
"	35	<i>Killough.</i>	
"	35	<i>Ballymoreen.</i>	

COUNTIES.	No. of Ordovician Shales.	LOCALITIES.	REMARKS.
Wicklow.	35	<i>Ballymurtagh.</i>	WEST OVOCA, or BALLYMURTAGH, MINES— <i>Metamorphic Ordovician</i> .—The old mines were worked for copper, sulphur ore and iron. The prospects in Kilcasshel and Knockanode not good. At Tinnahinch and Kilqueeny no trials have as yet been made.
"	35	<i>Ballygahan, Upper.</i>	
"	35	" <i>Lower.</i>	
"	35	<i>Tinnahinch.</i>	
"	35	<i>Kilqueeny.</i>	
"	35	<i>Kilcasshel.</i>	
"	35	<i>Knockanode.</i>	EAST OVOCA, or CRONEBANE, MINES— <i>Metamorphic Ordovician</i> .—Worked principally for sulphur ore, copper, iron, and ochre; at East Cronebane (Magpie), Connary, and Kilmacoo also for lead. At the latter mines there is the peculiar mineral, Kilmacooite.— <i>See Lead list.</i>
"	35	<i>Tigronay.</i>	
"	35	<i>Cronebane.</i>	
"	35	<i>Castlehoward.</i>	
"	35	<i>Avondale (Meetings).</i>	
"	35	<i>Shroughmore.</i>	
"	35	<i>Connary, Upper.</i>	
"	35	<i>Kilmacoo.</i>	
"	35	<i>Kilmaorea.</i>	
"	36	<i>Templeyon.</i>	Redcross— <i>Metamorphic Ordovician</i> .—Associated with sulphur and iron ores. Some good looking "tumblers" of copper picked up at Ballykean.
"	35	<i>Ballykean.</i>	
"	30 & 31	<i>Ballycapple.</i>	Wicklow, BALLYCAPPLE MINES— <i>Metamorphic Ordovician</i> .—Worked about 150 years ago for iron ore, which is a back to copper and sulphur ore.
"	31	<i>Ballard.</i>	

SULPHUR AND GOSSANS.

[Sulphur occurs native, as concretions in the Carboniferous Limestone, in the counties of Galway, Mayo, and Wexford; but the principal Irish ore from which it is obtained is the sulphide of iron (*pyrite*): but in the Co. Galway pyrrhotite, or magnetic pyrites, is found, and has also been mined. These ores usually contain some units of copper (*chalcopyrite*): the more of the latter present, the greater the value of the ore; as after the sulphur is obtained copper can be abstracted from the ash. Some of the pyrrhotites are nickeliferous. Some conspicuous gossans and strong chalybeate springs will be included in this list; in some cases they may only indicate the presence of iron, yet in many cases they come from pyrite veins. The localities where the quantity of pyrite is small and valueless are not given.]

COUNTIES.	No. of Ordovician Shales.	LOCALITIES.	REMARKS.
Cavan.	4 & 5	<i>Legnagrove.</i>	District of Glen, Native sulphur (?) (<i>Given in Lewis, but not of late years verified.</i>)
"	5	<i>Dowra.</i>	
Clare.	36	<i>Ballygeryin.</i>	Tulla— <i>Carboniferous</i> .—Sulphur, lead, and copper.
"	36 & 44	<i>Shannaknock.</i>	Broadford— <i>Ordovician</i> .—Coppery sulphur.

COUNTIES.	N. o. of Copper Sulph.	LOCALITIES.	REMARKS.
Cork.	107 & 108	Demesne.	Dunmanway— <i>Devonian</i> (?)—Said to be mundio, or poor ore.
"	67	Fever Hospital.	Youghal— <i>Devonian</i> (?)—Strong spa.
"	146	Kilcrohane.	Crookhaven — <i>Devonian</i> . — Thick lode sulphur ore with copper.
Donegal.	20	Carrowmore, or Glentogher.	Carndonagh— <i>Ordovician</i> , or <i>Cambrian</i> . Sulphur, silver-lead, and zinc.
"	15	Marfagh.	Dunfanaghy— <i>Cambrian</i> , or <i>Ordovician</i> . Sulphur, copper, lead, and iron. The lode was principally worked for the lead.
"	66 & 67	Sraig's Mountain.	Fintown— <i>Ordovician</i> , or <i>Cambrian</i> .—Sulphur, lead, and zinc.
"	27	Carlan.	Carrowkeel— <i>Ordovician</i> .—Very strong, large, reddish spas.
"	35 & 36	Goldrum and Cash- eleenan.	Kilmacrenan— <i>Ordovician</i> (?)—N. 10 W. lode, 3 feet wide; in part flucan, and in part quartz, with coppery sulphur ore; underlying eastward at 75°. Also a N. 20 E. quartz lode, with coppery stains and strong coppery spa.
"	36	Ballyscanlan (Fern Hill).	Millford— <i>Ordovician</i> .—A nearly N. and S. line of strong spas.
"	62	Fycorranagh.	Letterkenny — <i>Cambrian</i> (?) — Strong, reddish spas in the glen at the north-western boundary of the townland.
			NOTE.—In the metamorphic rocks (<i>Ordovician</i> , or <i>Cambrian</i>) there are numerous spa springs; some are solely due to the leaching of the iron (<i>carbonate</i> ?) out of the rocks; but when in lines along a line of break, or dyke, they may possibly point to mineral lodes.
Down.	26	Spa Cottage.	Ballynahinch— <i>Ordovician</i> .—Iron spa.
"	45	St. John's Point.	Killough — <i>Ordovician</i> .—Sulphur and copper.
"	34	Lismaliggaun.	Banbridge— <i>Ordovician</i> .—Iron spas.
"	34	Tanvally.	
"	26 & 25	Finnisbridge.	
Galway.	—	—	NOTE.—For sulphur ore in the Co. Galway Carboniferous limestone see Lead and Copper lists.

COUNTIES.	No. of Ordance Sheet.	LOCALITIES.	REMARKS.
Galway.	54	Eighterard.	Oughterard— <i>Carboniferous Limestone</i> .
"	54	Carrowmanagh.	—Concretions of native sulphur.
"	54	Fough.	
"	40	Ballygally.	Oughterard— <i>Metamorphic Cambrian</i> , or
"	40	Gowlaun.	<i>Ordovician</i> . — At Derreenagussore
"	40	Gortnashingaun.	the ore is magnetic pyrites (<i>pyrrhotite</i>).
"	40	Farravaun.	In some of the copper mines
"	40	Drumminnakill.	in this district there are considerable
"	40	Newvillage.	quantities of sulphur ore.— <i>See Lead</i>
"	54	Derryeighter.	<i>and Copper lists</i> , and <i>Geological Survey</i>
"	53	Leam East.	<i>Mem. Ex. Sheets</i> 93, 94, 95, and 105.
"	53	Letterfore.	The mine at Ballygally was one of
"	39	Curran.	the first opened; it was worked by
"	39	Derreenagussore.	Nimmo.
"	39	Derry.	
"	94	Galway Dock.	Galway— <i>Ordovician</i> .
"	90	Maumeen.	Gorumna Island — <i>Granite</i> .—Coppery
"	90	Teeranea.	sulphur ore.
Galway.	27	Ashford.	Cong— <i>Carboniferous</i> .
"	40	Doorus.	" <i>Ordovician</i> .
"	39	Doughta.	Maum Bridge— <i>Metamorphic Cam-</i>
"	39	Maumwee.	<i>brians</i> (?)—At Maumeen, Lackavrea,
"	39	Lackavrea.	and Maumwee the ore is coppery
"	38	Maumeen.	pyrrhotite, in part slightly nickle-
"	38	Teernakill, South.	iferous.
"	25	Cur.	
"	25	Teernakill, North.	
"	10 & 23	Dawrosmore.	Clifden— <i>Metamorphic Cambrian</i> (?)
"	9 & 10	Cloonlocaun.	
"	9	Cashleen.	
"	21	High Island.	
"	22	Booldard.	
"	35	Drimmeen.	
"	24	Kylemore.	Recess— <i>Metamorphic Cambrian</i> .—The
"	24	Gleninagh.	Ore is pyrrhotite. A little west of
			Recess are gossany "shode stones."
Limerick.	—	—	NOTE.—For sulphur ores <i>see lists of the</i>
			<i>Co. Limerick Lead and Copper mines</i> .
Mayo.	86	Louisburgh.	Vicinity of . . — <i>Silurian</i> .—Coppery
			sulphur.

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Mayo.	65	Achill Island.	Molrenny (Clew Bay)— <i>Metamorphic Ordovician</i> (?)—Coppery sulphur.
"	65	Clare Island.	
"	65 & 75	Curraun Achill (Gubnabinnia Bay).	
"	114	Bofin Island.	Cleggan — <i>Metamorphic Ordovician</i> .—Coppery.
"	121	Ballycurrin.	Headford — <i>Carboniferous</i> . — Sulphur and lead.
"	121	Gortbrack.	
			NOTE.—For sulphur ore in the Mayo Lead and Copper Mines, see <i>Lead and Copper lists</i> .
Tipperary.	—	—	At Lackamore mine, near Newport, and in different places in Silvermines, there is sulphur ore associated with the lead, &c. In the latter (Cloonagh) there is a great "ramp" of poor ore (<i>mundic</i>).—See <i>lists Lead and Copper</i> .
Tyrone.	45	Aghafad.	Pomeroy— <i>Silurian</i> .—Coppery gossans; none of the lodes proved.—See <i>Copper list</i> . In the country hereabouts, and to the westward in the large tract of <i>Silurian</i> rocks of the <i>Lower Devonian</i> type, are many good-looking indications of minerals.
"	45	Shanmaghry.	
"	45	Lurganeden.	
"	45	Glenbeg.	
Wexford.	25	Bree.	Enniscorthy— <i>Ordovician</i> .— <i>Mundic</i> . NOTE.—The iron ore at Ballybrennan (see <i>Iron list</i>) may possibly be the back of a sulphur ore lode.
Wicklow.	30 & 31	BALLYCAPPEL MINES.	The principal minerals in these mining setts, all of which lie in the <i>Mineral Channel</i> of the Ovoca valley, are coppery sulphur ores. Some of the best of these, however (in old times), were worked solely for the cooper in them.—See <i>Copper list</i> .
"	35	KILMACREA "	
"	35	EAST OVOCA "	
"	35	WEST OVOCA "	
"	39 & 40	SOUTH-WEST OVOCA MINES.	
"	39	CARTSFORT MINES.	

BARYTES.

[Only the localities where the ore is known to be in quantity are given.]

COUNTIES.	No. of Square Miles.	LOCALITIES.	REMARKS.
Cork.	118	<i>Derreenagreenagh.</i>	Bantry— <i>Yellow Sandstone</i> , or <i>Devonian</i> .
"	118	<i>Derryginagh.</i>	—With a little copper.
"	119		
"	140	<i>Ballycumisk.</i>	Ballydehob— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—The ore in one lode is so mixed with copper ore that both are valueless.
	139	<i>Mount Gabriel.</i>	Skull— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—A little copper.
"	143	<i>Little Island.</i>	Roscarberry— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Some copper.
Down.	39	<i>Gun's Island.</i>	Ardglass— <i>Ordovician</i> .—With lead and copper.
"	51 & 54	<i>Dromore.</i>	Vicinity of . . — <i>Ordovician</i> .—With lead.
"	45	<i>Rathmullen.</i>	Killough— <i>Ordovician</i> .—With lead.
Galway.	54	<i>Clooshereen.</i>	Oughterard— <i>Metamorphic Ordovician</i> , or <i>Cambrian</i> .—With copper and sulphur ore. Griggins is in the Maum Valley.
"	54	<i>Canrawer.</i>	
"	54	<i>Cregg.</i>	
"	25	<i>Griggins.</i>	
"	42	<i>Bunnaconeen.</i>	Headford— <i>Carboniferous</i> .
Limerick.	25	<i>Oolahill.</i>	Oola— <i>Carboniferous</i> .—With lead and copper.
Londonderry.	40	<i>Cavanreagh.</i>	Draperstown— <i>Carboniferous</i> .—Veins in sandstone.
Monaghan.	25	<i>Carrickaganran.</i>	Castleblaney— <i>Ordovician</i> .—With silver-lead.
"	25	<i>Cornalough.</i>	
"	14	<i>Coolertragh.</i>	Monaghan— <i>Ordovician</i> .—With silver-lead and zinc.
Sligo.	5 & 9	<i>Glencarberry</i> (King's Mountain).	Sligo— <i>Carboniferous</i> .—With some copper and lead.
Wexford.	43	<i>Killane.</i>	Wexford— <i>Carboniferous</i> .—With lead.
"	43	<i>South Intake.</i>	
Wicklow.	23	<i>Barrover.</i>	GLENMALUR MINE, Rathdrum— <i>Granite</i> and <i>Mica schist</i> .—With lead and zinc: very pure.

IRON.

[The Irish iron ores occur in bedded masses and in veins. In the recent accumulations, principally the alluvium and bog, iron occurs very frequently, often associated with manganese (*Wad*) as *bog-iron-ore*. In the Cainozoic rocks of Antrim and Derry are allied ores known in the trade as the "Belfast Aluminous Ore," which occur as bedded masses in the Eocene (?) Dolerytes. In the rocks of the Carboniferous period are clayey chalybites, as nodules and layers in the Calp and Coal Measures, while in the purer limestones of the same period, and the older Devonian, Ordovician, and Cambrian rocks, are regular veins and bunches of hematite, limonite, and chalybite. Some of the iron ores, however, in these older rocks, seem in part to be bedded or to partake of the nature of the veins known as *lay in lay*, that is, they underlie in the bedding of the associated rocks. Some, however, seem, and may be, more intimately connected with the associated strata, as a portion of a bed or beds may have been feriferous, thus forming a bedded "bunch of ore."

The localities where "bog-iron-ore" occur are so numerous, that it would be impossible to enumerate them, but when particularly conspicuous they will be referred to. During the smelting operation in the 16th and 17th centuries, when the Irish iron industry appears to have been at its height, these bog ores seem to have been extensively worked to mix with the other ores. At the present time a peaty variety is at times extensively exported to England and Scotland, principally from Donegal, to be used for the purification of gas and other purposes. In general, it is found as layers in the peat, and may be from blackish to a dirty white in colour, but more often it is of a pale yellowish green; these, when exposed to the air, rapidly oxidize, changing in colour to yellow or reddish yellow. The bog-iron-ore is employed by gas manufacturers to purify the gas from sulphuretted hydrogen. In the process the ore becomes charged with sulphur and ammonia.

Mr. W. E. Adeney states: "After it had been used for the purification of the gas, the ammonium salts are first extracted from the spent ore by means of water; the fine feriferous powder deposited being very valuable in the manufacture of brown paint. The residue then is dried and burnt for sulphuric acid manufacture. The cinder left after burning off the sulphur can be sent back to be re-used for washing gas."

It appears remarkable, that the older deposits of bog-iron-ore, especially in the alluvium, are of much greater magnitude than any that are now accumulating. This possibly may be due to the older masses being, in a great measure, the leaching from the surface rocks; which leaching process, being now long since accomplished, the present depositions have to depend solely on the iron brought up in springs from more or less deep-seated rocks].

BEDDED IRON ORES.

[These are arranged in groups, beginning with the younger formation, which necessitates the counties not being arranged in alphabetical order.]

EOCENE (?)

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS
Antrim.	—	Knockbay.	<i>Antrim Iron Measures—Limonite.</i> —In lenticular bedded masses in the dolerite; apparently on different geological horizons: the better and richer beds being higher than the others. Associated with <i>lithomarge</i> (ferrous clay), <i>bole</i> (a poor clayey iron ore), <i>alumite</i> (alum clay), and <i>lignyte</i> —(see <i>Alum and Copperas list</i>). The best developed beds occur principally in the eastern and northern portions of the county. The iron ores proper consist of the First, or <i>pisolitic ore</i> , and the Second, or <i>aluminous ore</i> ; but in some cases in the underlying lithomarge are lenticular masses of bole of a quality equal to the "Second ore." At Killymurriah, according to the records of a bore-hole, the Iron Ore Measure rested on White Limestone, as at Craig-na-Shoke, Co. Londonderry.
"	—	Ballylig.	
"	—	Broughahane.	
"	—	Glenravel.	
"	—	Cargan.	
"	—	Newtown Crommelin.	
"	—	Glenariff.	
"	—	Carnlough.	
"	—	Glenarm.	
"	—	Killymurriah.	
"	—	Shanehill.	
"	—	Larne, west of.	
"	—	Island Magee.	
"	—	Ballypalady.	
"	—	Port Moon.	
"	—	Rathlin Island.	
"	—	Kellygar.	
"	—	Swanstown.	
"	—	Tully.	
"	—	Kinboe.	
"	—	Cullaleen.	
"	—	Pharis.	
Londonderry.	35	Craig-na-shoke.	<i>Limonite.</i> —Two miles N. N. E. of Moneyeany there is a bed at the base of the Eocene dolerites, associated with lignyte and the Basal chalk (<i>White Limestone</i>) conglomerate. There is a tradition that Rennie, about 1600, worked a similar ore on Slieve-Gallion-Carn, but none of the ore can now be seen.
"	35	Moydamlaght.	
"	35	Bohilbreaga (Dunmurray).	
"	41	Slieve-Gallion-Carn.	

COAL MEASURES (Carboniferous).

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Carlow. Kilkenny. Queen's Co. Tipperary.	— — — —	LEINSTER AND EAST MUNSTER COAL- FIELDS.	Layers of nodules and thin seam of <i>clay-iron stone</i> on different horizons. The most productive beds occur a little below the lowest coal (<i>Gale Hill</i> , or <i>Oullenagh</i> , coal), and were extensively worked in the Queen's County in the 16th and 17th centuries. These ores were used at the furnace near Mountrath (Coote's) to mix with Bog and Carboniferous ores.—(See <i>County History</i> .)

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Cork. Kerry. Limerick. Clare.	— — — —	WEST MUNSTER COAL- FIELDS.	Layers and nodules of <i>clay-iron stone</i> : principally associated with the lower coals—they were worked very extensively in the 16th and 17th centuries in the counties Limerick and Clare adjoining the Shannon. Iron ore was smelted at Glin, Loghill, &c. ; but a portion of the ore seems to have been sent up the Shannon, to the furnaces on Lough Derg, to be mixed with Bog and Ordovician ores. —(<i>See County History.</i>)
Mayo.	—	Slievecarra.	The hills northward of Balla.—Clay-iron stone associated with the lowest coal.—(<i>See County History.</i>)
Sligo. Roscommon. Leitrim. Fermanagh.	—	CONNAUGHT COAL- FIELD.	This field, although in general called after the province of Connaught, lies nearly equally in the province of Ulster. The iron-producing measures are in the Middle Coal Measures, and considerably below the geological horizon, in which the more profitable beds are found in Leinster and Munster. The iron (<i>clay-iron stone</i>) was extensively smelted formerly, and apparently at a later date than in the southern province—the fires having been put out when the wood-fuel was exhausted. In the Co. Fermanagh, at the foot of the Cuilcagh mountains, there were extensive excavations, furnaces, and mills; also in the Co. Leitrim—the last fire, at Drumshambo, having been put out in A.D. 1766. In the Co. Roscommon the three brothers O'Reilly first attempted in Ireland to smelt iron with coal: they, in 1788, establishing the Arigna Iron Works, and opened coal pits—the adventure, by them and others, being carried on till 1808. Since then others have tried. Full particulars of the more recent works are given hereafter in the <i>County History</i> .
Tyrone.	46	Drumglass (Dungannon).	TYRONE COAL-FIELD.—These are more or less detached. In none of them has much <i>clay-iron stone</i> been recorded. This possibly may be due to the measures—which in Connaught and elsewhere have produced most ore—being in this country more or less covered up by deep drift, and consequently not explored.
"	47	Annagher.	
"	46 & 47	Coalisland.	
"	39	Annaghone (Tullahogue).	

CALP (Carboniferous).

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Antrim.	—	BALLYCASTLE COAL-FIELD.	<i>Clay-iron Stone</i> .—Worked in ancient times with the coal; also in the beginning of the eighteenth century, the ore having been smelted at Ballycastle by Mr. Boyd.—(See <i>County History</i> .)
Dublin.	5 & 8	Baldongan Hill.	Skerries—Poor <i>Clay-iron stone</i> .
"	8	Donabate.	
Londonderry.	41	Drumard.	
"	41	Mormacul.	Draperstown— <i>Clay-iron Stone</i> .—Worked principally in Drumard, by Rennie, about 1600, and "smelted at the Drumlamph Iron Works." At the Moyola River, in the south part of Drumconready, there are the ruins of an old furnace.
"	41	Brackaghlistee.	
Mayo.	20 & 28	Crossmolina.	
"	9 & 10	Tallagh.	Barony of Erris— <i>Carboniferous</i> (?)—The exact position where the iron was raised for the use of Sir George Shaen's furnace near the Mullet, and Mr. Rutledge's, on the River Deal, is now uncertain; but it would appear as if the ore was procured, in part at least, from the Calpy limestone (<i>clay-iron stone</i>). Rutledge was the last to work, his fires being put out for want of fuel.—(See <i>County History</i> .)
Tyrone.	20 & 28	Kildrees.	Cookstown— <i>Limonite</i> and <i>Hematite</i> .—Extensive trials made about 1880 by the Barrow Hematite Company; but the works were stopped on account of the low prices for iron.
"	—	DRUMQUIN CALP AREA.	Omagh—Nodular beds of <i>Clay-iron stone</i> .—Here, as near Draperstown and Cookstown, there are rocks belonging to the Ulster "calp type," in which the clay-iron stone is of a fair character.
Wexford.	40	Wearway Bay.	Hook Promontory, Fethard—Poor <i>Clay-iron stone</i> .—The ore is of a quality like that near Donabate, Co. Dublin. The associated rocks are also somewhat similar, but they rest on Carboniferous conglomerate (Upper Old Red Sandstone); in this locality they are probably a littoral accumulation.

IRON ORE IN VEINS.

[The mode of occurrence of some of the ores in this list is not as true veins; yet at the same time they are not in true beds. Like the ores of the Eocene and Coal Measures, they are apparently of a secondary formation, a part of a bed or beds becoming ferriferous, the ore being found in an irregular "bunch" or "shoot" that underlies with the stratification of the associated rocks. This is especially the case with some of the ores in the Ordovician rocks which have been described as "beds of ore." The localities of some of the ancient iron mines are now quite unknown, while the exact sites of others are uncertain. In the latter cases the places in the neighbourhood of which the mines were probably situated will be mentioned. The localities are arranged in counties.]

COUNTIES.	No. of Ordinan ^e Sheet.	LOCALITIES.	REMARKS.
Cavan.	16	Claragh.	Redhill— <i>Ordovician</i> .—Ochre and limonite (?) The veins lie with the bedding of the rocks: ores worked in 1875.
Clare.	19 & 27	Glendres.	Feakle — <i>Ordovician</i> Limonite (?) — Worked prior to 1700. The adit of the ancient mine is still to be seen; but the exact position or nature of the lode is unknown. Tradition says that the ore was smelted at the present village of Furnace, a few miles eastward of Feakle. One mile N.E. of Feakle church are old <i>burrows</i> , where there is said to have been an "iron mine." The exact position of the lode is uncertain, without explorations.
"	43 & 44	Ballykelly.	Broadford— <i>Ordovician</i> .
"	—	Knockmaghta.	Sixmilebridge — <i>Ordovician</i> .—Hematite and Limonite, with Graphite.
"	28, &c.	Ballymalone. Bealkelly.	Tomgraney — <i>Ordovician</i> . — Limonite. Worked rather extensively in the 16th(?) and 17th centuries, principally for the furnaces along the shore of Lough Derg between Mt. Shannon and Woodford, where it was mixed with bog-iron-ore raised in that country, and "ore brought up the Shannon," probably from the Coal Measures, counties Limerick, Kerry, and Clare.
Cork.	128	Bear Island.	Bearhaven, or Castletown— <i>Carboniferous Slats</i> .—A well-marked vein of hematite, associated with micaceous iron ore.

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Cork.	142	<i>Aghatubrid.</i>	Rosscarbery— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Limonite associated with manganese, the latter being in shrinkage fissures in the iron ore. The iron ore seems to occur as the back of a copper lode.
"	143	<i>Roury Glen.</i>	
"	143	<i>Rosscarbery.</i>	
"	118 (F)	<i>Coomhola.</i>	Glengariff— <i>Carboniferous Slate</i> (?) or <i>Yellow Sandstone</i> (?)—A mine is recorded in this locality by Smith, in his history of Cork, 1750. Worked by the Whites, who had a furnace in the vicinity.
Cork.	—	<i>Aghadown.</i>	Roaring-water Bay and Tallow Bridge.—These localities are also mentioned by Smith, the first being worked by the Whites, the second by the Earls of Cork. According to Smith, 1750, iron was smelted by the Whites at Coomhola and Aghadown, and by Lord Cork at Araglin, "near the eastern extremity of the county;" while Gerrard Boate (1652) states the iron was smelted at Tallow Bridge. A few miles eastward of the latter, at Salter's Bridge, in the Co. Waterford, are the remains of old iron works, said to have been worked in the 17th century.— <i>See Drumslig, Co. Waterford.</i> The sites of the mines near Roaring-water Bay and Araglin are now unknown, but they were probably in the <i>Yellow Sandstone</i> , or <i>Devonian</i> , rocks of the vicinities.
"	—	<i>Araglin.</i>	
"	117	<i>Rooska.</i>	Bantry— <i>Carboniferous Slate</i> .—Chalybeate (<i>carbonate of iron</i>), with lead and copper: worked for the lead.
Donegal.	68	<i>Walshtown.</i>	Ballybofey— <i>Ordovician</i> .—With lead: the mine worked for the latter.
"	15	<i>Marfagh.</i>	Dunfanaghy— <i>Ordovician</i> (?) or <i>Cambrian</i> (?)—With lead, copper, and sulphur ore: the mine worked, principally for the lead.
"	30	<i>Skreen, Lower.</i>	Milford— <i>Ordovician</i> (?)—Limonite. In a mass of schist caught up in an intrude of whinstone. In the vicinity is a quantity of slag, as if smelting had formerly taken place.

COUNTIES.	N ^o . of Copper Shots.	LOCALITIES.	REMARKS.
Donegal.	53	Meenreagh.	Letterkenny — <i>Cambrian</i> (?) — Impure <i>chalybeate</i> ; appears to be more or less in bedded masses in the associated rocks. NOTE.—As has been pointed out by different recorders, the remains of ancient bloomeries and forges, used in the smelting of iron prior to the woods of the country having been used up, are found in different places scattered over the County.
Down.	35	<i>Deeshommed</i> .	Banbridge — <i>Ordovician</i> . — Hematite. This vein has only been discovered about ten years. The ore appears to be of a good quality; but on account of the depression in trade it has not been worked.
„	23	Spa Cottage.	Ballynahinch — <i>Ordovician</i> .
„	23 &c.	Slieve Croob.	Dromara — <i>Ordovician</i> . (F) — In this tract of mountains, Griffith records iron in the townlands of Begny, Gransha, Leganary, Moneybane, &c.
„	14	Carnreagh.	Hillsborough — <i>Ordovician</i> .
Dublin.	9	Lambay Island.	Skerries — <i>Intrusive Rocks</i> . — Blocks of hematite recorded by Du Noyer, as occurring a little S.W. of Raven's Well, near Bishop's Bay. Supposed to be from the back of a copper lode.
Fermanagh.	9	Rossbeg (Castle Caldwell).	Belleek — <i>Carboniferous</i> (?) — Limonite. Supposed to be the back of a copper lode. At Magherameragh a little copper was raised by the late Mr. Johnstone.
Galway.	39	<i>Drummau</i> (Doon).	Maum Bridge — <i>Metamorphic Ordovician</i> . — Hematite (?); with manganese, copper, and lead: worked for the lead.
Galway.*	35	Derreen.	Clifden — <i>Ordovician</i> . — Limonite in limestone.

* In the west of this county iron ore veins are not recorded; but in olden times ore was smelted in places, such as Lough-na-Furnace, Screeb, and in other places on Galway Bay or its inlet. In these places, however, it may have been bog-iron ore that was used, mixed with imported ore—as the records inform us that iron ore was imported into places along the west coast to be smelted, on account of the abundance of timber; the old iron being made with wood charcoal. In the south-east of the county there were extensive furnaces and mills adjoining Lough Derg, the last in work, that of Woodford, having its fires put out about the year 1750. The iron ores for these furnaces and mills were procured in the vicinity (*bog-iron ore*) near Tomgraney, Co. Clare (*limonite*), and from the Lower Shannon,

COUNTIES.	No. of Ordian's Sheet.	LOCALITIES.	REMARKS.
Kerry.*	—	—	—
Kilkenny.	28	Grenan.	Thomastown— <i>Ordovician</i> .—Red hematite (<i>micaceous</i>).
Leitrim.	35	Gortinas.	Drumsna— <i>Ordovician</i> .—Limonite raised here; probably in the 16th or 17th century. When making the railway from Longford to Sligo three bed-like veins of slaty limonite, bearing nearly N.E. and S.W., and having S.E. at 60° were cut. Subsequently they were worked, two shafts being sunk for a depth of thirty feet about the year 1870, by which the ore was proved to improve in depth. On the depression in the iron trade the works ceased (<i>See County History</i>).
Limerick.	11	Askeaton.	Askeaton— <i>Carboniferous Limestone</i> , <i>Silicious Limonite</i> .—The ore at Kilcolman was worked about the 17th century, and subsequently about the years 1870–75.
"	—	Kilcolman.	
Londonderry.	31	Carrick Mountain.	Dungiven— <i>Ordovician</i> (?)
"	29	Glenrandal.	Stranagallwilly— <i>Ordovician</i> .—Mass of Ochre.
"	40 & 45	Tullybrick (Altihiskey).	Draperstown— <i>Ordovician</i> (?)—Red Hematite. One of Rennie's mines (A.D. 1600) is said to have been in this townland, but the site is now unknown.
"	45	Beaghbeg.	Tonaragh— <i>Ordovician</i> (?)—Red Hematite (<i>micaceous</i>).

counties Limerick and Clare (*clay-iron stone*). Hely Dulton, in his *Statistics, History Co. Galway, 1824*, states:—"Iron ore was formerly raised in the neighbourhood of Woodford, and after being mixed with that brought up the Shannon from Killaloe by a Mr. Crossdale, was smelted near that village, part of the estate of Sir John Burke. The works were carried on so extensively, that they devoured all the great oak woods with which that country abounded, and were then abandoned. Mr. Berry, I understand, at present raises ore on part of Lord Clanricarde's estate."

* At the present time there are no records of mines solely worked for iron, but along the coast-line are the remains of different furnaces. According to tradition these belonged to Petty (ancestor of the Lords Lansdowne), who imported iron ore about the year 1600, to smelt it with charcoal, made in the wood which then abounded in the country. Nennius, writing in the ninth century (*Historia Britonum*) mentions iron as being worked in the neighbourhood of Killarney Lakes; but the site of the old mine is now unknown. The remains of very ancient bloomeries and furnaces have been found at Killarney and Blackstones (*See County History*).

COUNTIES.	No. of Cham- ber- Sheet.	LOCALITIES.	REMARKS.
Londonderry.	40 & 45	(Unagh) Slieve Gallion Carn.	Money more— <i>Granite</i> .—Hematite in a four-foot vein of ferriferous quartz: worked by Rennie in 1600, and recently, about 1875.
„	46	Tirgan and Carndaisy.	Money more— <i>Granite</i> .—Four-foot lode, being N.S.S.W., and having S.W. at 8°; rich fibrous hematite (<i>kidney ore</i>), and <i>red ochre</i> : worked by Rennie, and recently.
„	45 & 46	Slievemoyle.	Money more— <i>Metamorphic Ordovician</i> .—Hematite and barytes: worked a little in 1875. A narrow, nearly vertical vein, with a north-westerly course.
„	46	Cranny (Glenview).	Desertmartin— <i>Metamorphic Ordovician</i> .—Hematite and barytes. A narrow, nearly vertical, lode, with a north-westerly course: worked a little in 1875.
Longford.	3	Cleenragh.	Arvagh— <i>Ordovician</i> .—These bed-like veins of limonite are similar to those at Gortinee, Co. Leitrim; but the ore at Cleenragh is of a better quality, while that at Enaghan is not as good. Worked in the 16th or 17th century, and rather extensively, by Dr. Ritchie of Belfast, between 1860–70.
„	3	Enaghan.	
Louth.	22	Clogher Head.	Clogher— <i>Ordovician</i> .—Limonite.
Mayo.	—	Carricknahelty.	Molrany— <i>Ordovician</i> .—Limonite.
„	75	Curraun Hill.	
Meath.	2 & 3	Corratober.	About two miles to the south-east of Kingscourt are numerous tumblers and fragments of hematite. Source not known; possibly near at hand.
Queen's Co.	13 & 18	Dysart.	Maryborough— <i>Carboniferous Limestone</i> .—Limonite: worked extensively in the 16th and 17th centuries, the ore having been brought to be smelted to Coote's furnace, at Mountrath.
„	13	Dunamase.	
Sligo.	27	Ballynakill.	Riverstown— <i>Carboniferous</i> .—Hematite veins in the bedding lines. An ancient furnace close to the mineral veins.

COUNTIES.	N ^o . of Ordnance Sheet.	LOCALITIES.	REMARKS.
Sligo.	21	Ballintogher.	Ballysaulare.—There are old iron mines recorded at Ballintogher. At the base of the Ox Mountains were very extensive workings; while furnaces and mills were situated at Screevenamuck; the fire having been put out in 1768 for the want of wood-fuel (<i>See County History</i>).
Tipperary.	45	Scotchman's Coom.	Cappaghwhite— <i>Ordovician</i> .
"	33	Gortnahulla.	In the valley of the Clodiagh, Borrisoleigh — <i>Ordovician</i> . — Limonite. A very old mine; when and by whom worked is not known. The iron ore seems to be the back of a copper or sulphur ore lode. Tradition says there was a second mine to the N.E., near Roscrea, but the site seems to be now unknown.
Tyrone.	29	Lissan.	Cookstown— <i>Carboniferous</i> .—Hematite, limonite, and ochre, with manganese. Worked in 1600 by Rennie, and subsequently between 1865 and '75.
"	37	Bardaheesiagh.	Pomeroy— <i>Metamorphic Cambrian</i> (?)—This occurs in a mass, and appears to be an intrude of whinstone highly impregnated with magnetite. It has been worked as an iron ore, but not successfully.
"	37	Limehill.	Pomeroy— <i>Granite</i> .—An impure chalybeate in an irregular vein.
Waterford.	7	Killerquile.	Carrick-on-Suir — <i>Ordovician</i> .—Hematite (<i>micaceous-iron-ore</i>).
"	35	Dromslig.	Dungarvan— <i>Devonian</i> , or <i>Yellow Sandstone</i> .—Hematite discovered and worked by Walter Raleigh about, or a little before, 1600. Subsequently worked between 1850 and 1860.
"	35	Grallagh.	
"	39	Mine Head.	Ardmore— <i>Devonian</i> , or <i>Yellow Sandstone</i> .—Limonite. Probably worked in the 17th century.
"	40	Ardmore.	

COUNTIES.	No. of Ord. Sheet.	LOCALITIES.	REMARKS.
Wexford.	31	Ballybrennan.	Enniscorthy— <i>Ordovician</i> .—The workings here appear to have been ancient, as nearly all traces of them are obliterated.
"	7	Ballynastragh.	Gorey— <i>Ordovician</i> .—These accumulations are in part of the nature of beds. At and in the neighbourhood of Ballynastragh portions of a bed or beds of purple slate are highly ferri-ferrous (<i>limonite</i>). Near Courtown the same ore occurs as strings or veins in the rocks, while northward of Ballymoney Fishery there are lenticular beds of poor <i>chalybeate</i> .
"	12	Courtown Harbour.	
"	7	Ballymoney.	
Wicklow.	6	Cloghlogh.	Blessington (Glenasplinkree)— <i>Meta-morphic Ordovician</i> .—Limonite, hematite, and manganese; worked a little.
"	5	Knockatillian.	
"	42	Aughowle Upper.	Shillelagh— <i>Metamorphic Ordovician</i> .—Limonite. Some trial made on the vein about 1875. Iron ore is said to have been raised in this locality in Bacon's and Chamney's time (16th and 17th century); but the sites of their works are now unrecorded.
"	32	Tinnahely.	North of . . — <i>Metamorphic Ordovician</i> .—A ramp of limonite partaking of the nature of bog-iron-ore; for the most part at the surface, or only under a thin drift: in places it is copper-stained. No traces of old or recent works in connexion with it are apparent.
"	29 & 34	Mucklagh.	Rathdrum—A rather extensive ferriferous conglomerate on <i>Metamorphic Ordovician</i> (?). Unsuccessfully open casts were made in part of it (1875), to try and find its source.
"	30	Moneyteigue.	Woodenbridge, CARYSPORT MINES— <i>Metamorphic Ordovician</i> .—Limonite: the backs of copper and sulphur-ore lodes. Very ancient working appears to have existed here; while in recent years some tons of ores have been raised at Moneyteigue.
"	30	Ballycoog.	
"	30	Ballynasillago.	
"	40	Mongaun.	Arklow— <i>Metamorphic Ordovician</i> .—A large ferriferous mass, somewhat like that at Mucklagh. No trials have been made to seek for its source.

COUNTIES.	No. of Ordance Sheet.	LOCALITIES.	REMARKS.
"	40	<i>Knocknamehill.</i>	SOUTH-WEST OVOCA, OR KNOCKNAMU- HILL MINES— <i>Metamorphic Ordovi- cian.</i> —Limonite: the backs of copper or sulphur-ore lodes; worked in the 17th century, the ore being sent to Chamney's furnaces at Ballynaclash, Shillelagh, &c.
"	35 & 40	<i>Balkinapark.</i>	
"	35	<i>Ballymonam.</i>	
"	35	<i>Ballymurtagh.</i>	
"	35	<i>Castle Howard.</i>	WEST OVOCA MINES— <i>Metamorphic Ordovician.</i> —Limonite with copper- staining on the shrinkage fissures, and ochre. The back of the North sulphur lode was not worked till recent years, and iron is at present being raised: of late the ochre has been worked.
"	35	<i>Cronebane.</i>	
"	35	<i>Connary.</i>	
"	35	<i>Kilmacoo.</i>	
"	36	<i>Templeton.</i>	Redcross— <i>Metamorphic Ordovician.</i> — Limonite.
"	30 & 31	<i>Ballycapple.</i>	WICKLOW— <i>Metamorphic Ordovician.</i> — Limonite, magnetite, chalybeate, and ochre, with manganese: seems to be the back of a copper or sulphur-ore lode. Here there were extensive works in the 17th century, the ore being smelted by Chamney in the Vale of Clara, at Ballynaclash furnace, &c.; the old mines are still called the "Clash pits."
"	31	<i>Ballard.</i>	

MANGANESE.

[This mineral is very universally distributed, but generally more or less minutely; it is very often associated with bog-iron-ore, or other iron peroxides. In many cases it is valueless. In this list are only given the localities where it might possibly be worked profitably as a bye-product with the associated minerals.]

COUNTIES.	No. of Ordance Sheet.	LOCALITIES.	REMARKS.
Armagh.	19	<i>Clay.</i>	Keady— <i>Ordovician.</i> —With lead; not in large quantity.
Clare.	6	<i>Cappagh.</i>	Ballyvaughan— <i>Carboniferous.</i> —Asso- ciated with lead.
"	27	<i>Glendree.</i>	Feakle— <i>Drift.</i> —(<i>Diallogite</i>).

COUNTIES.	No. of Copper Sheet.	LOCALITIES.	REMARKS.
Cork.	143	<i>Aghatubrid.</i>	Rosscarbery — <i>Yellow Sandstone</i> , or <i>Devonian</i> . These mines are on one channel. In considerable quantity associated with iron and copper.
„	143	<i>Roury Glen.</i>	
„	143	<i>Rosscarbery.</i>	
Donegal.	89	Malinbeg.	Killybegs— <i>Metamorphic Ordovician</i> (?) — With silver-lead.
Galway.	39	<i>Drumnaue</i> (Doon).	Maumbridge— <i>Ordovician</i> .—With copper, lead, and iron.
Monaghan.	27	Corduff.	Bellatrain— <i>Ordovician</i> .
Tipperary.	74	<i>Aherlow Vale.</i>	Tipperary— <i>Ordovician</i> .—With silver-lead and copper.
Wicklow.	6	<i>Cloghleagh.</i>	Blessington (Glenasplinkeen) — <i>Mica Schist</i> .—With iron.
„	5	<i>Knockatillane.</i>	
„	30	<i>Ballycapple.</i>	Wicklow— <i>Ordovician</i> .—With iron and copper.
„	31	<i>Ballard.</i>	

ANTIMONY.

[It, in general, occurs as the sulphide (*stibnite*) associated with lead (*galenite*).]

COUNTIES.	No. of Ordovician Sheet.	LOCALITIES	REMARKS.
Clare.	34	<i>Monaoe</i> , or <i>Kilbreckan.</i>	Quin — <i>Carboniferous</i> .—With silver-lead.— <i>See Lead list.</i>
Cork.	142	Rabbit Island.	Castletownsend— <i>Yellow Sandstone</i> , or <i>Devonian</i> .—Associated with lead and copper.
Louth.	1	Jonesborough.	Vicinity of . . — <i>Ordovician</i> .
Monaghan.	14	<i>Lieglassan.</i>	Monaghan — <i>Ordovician</i> .— With lead. At Clontibret the vein of stibnite is four inches wide.
„	14	<i>Tullybrack.</i>	
„	14	<i>Clontibret.</i>	
Tyrone.	12 & 19	Munterlong Mountain.	Newtownstewart — <i>Ordovician</i> . — Recorded by <i>Griffith</i> .
Wicklow.	35	<i>Cronebane</i> (Magpie).	Ovoca — <i>Metamorphic Ordovician</i> .—In the <i>Kilmacooite</i> .— <i>See Lead list.</i>
„	35	<i>Kilmacoo</i> (Connary).	

ARSENIC.

[This mineral is very often present in small quantities associated with sulphur-ore (*pyrites*), and sometimes with lead. At Cronebane and Connary, Co. Wicklow (sheet 35), it occurs as arsenopyrite, locally called "Jack Martin," with the sulphur-ore, and in the Kilmaccoite (see Lead and Zinc); at Lackamore, Co. Tipperary (sheet 38), it occurs as arsenopyrite associated with copper ore; but in some places it occurs independently, as on the east shore of Adrigole Bay, Co. Cork (sheet 118), and at Gubnabinniaboy, near Molranny, Co. Mayo (sheets 65 and 75). In some of the mines of south-west Cork, as at Lissaremig, near Bantry (see Lead List), it occurs in considerable quantities.]

COBALT.

[Cobalt in quantity has only been recorded as occurring at Muckross, Co. Kerry, where, unfortunately, most of the ore (*erythrite*, or *arsenate of Cobalt*) was thrown into the lake before its value was discovered.—(*Kane*.)]

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Donegal.	35	Barnesbeg.	N. of Kilmacrennan.—Traces in pyrrhotite crystal. (<i>Scott</i> .)
Dublin.	15	Sutton.	Howth— <i>Carboniferous</i> .—With manganese. Discovered by <i>Dr. Stokes</i> .
Kerry.	74	Muckross.	Killarney — <i>Carboniferous</i> .—Associated with copper and pyrites. The major portion of the cobalt ore was thrown into the lake before its nature was discovered by <i>M. Raspe</i> in 1794.
Waterford.	25	Knockmahon.	Bunmahon — <i>Ordovician</i> . — Associated with copper, silver-lead, and zinc. Discovered by <i>J. H. Holdsworth</i> .

GRAPHITE (Plumbago).

[Graphite has been very little utilized, although in some places it seems to be in sufficient quantity to have been worked as a bye-product with the associated minerals.]

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Clare.	43	Knocksnacht.	Sixmilebridge— <i>Ordovician</i> .—In a vein with iron.
Donegal.	26	Sheephaven, near Ards House.	Dunfanaghy and Convoy.—Found as rolled pieces in <i>Gravel</i> .
"	69	Burndale.	
Kilkenny.	—	Castlecomer Coal-field.	<i>Carboniferous</i> .—Formerly associated with the "old Three-Foot Coal."
Mayo.	65	Toorrevagh.	Achill Island — <i>Ordovician</i> .—Graphitic micalyte to the east of Doonaglass Point. (<i>Mitchell</i> .)
Tipperary.	40	Gleninchinaveigh.	Upperchurch— <i>Ordovician</i> .—In a lode, associated, or mixed, with anthracite. The lode was worked to a depth of ten fathoms, when the walls closed in and cut it out.
Wexford.	7	Ballymoney.	Courtown— <i>Ordovician</i> .—Disseminated in beds of black shale.
"	20	Greenfield.	Enniscorthy— <i>Ordovician</i> .
"	25	Craan.	Wilton— <i>Ordovician</i> .—In a vein, associated with anthracite.
"	31	Doonoony.	Taghmon — <i>Ordovician</i> .—In a vein, associated with anthracite.
Wicklow.	30	Rathdrum.	N.E. of Rathdrum, Ovoca— <i>Ordovician</i> .
"	35	Avondale.	—In these places it occurs disseminated in black shaly clays locally called <i>Coal-ground</i> .
"	35	Cronebane.	

NICKEL.

[This mineral as yet has not been found in sufficient quantities to be profitable. It has, however, been detected in the *pyrrhotites* of the Maam and Gleninagh Valleys, Co. Galway. Hardman has found it in serpentine or allied rocks; such as *ophiolite*, Lissoughter; *talcyte* (?) Mullaghglass, Co. Galway; *ophyte*, Croagh Patrick; *steatite*, Bofin, Co. Mayo; and *ophyte*, or *eklogyte*, Sliahwood, Co. Sligo.

In America there is a magnesian rock which is worked profitably for the nickel it contains; therefore attention may be directed to a rock found S.W. of Leenaun, to the north of Glenisky Peak, Co. Galway, and to a similar one in Achill Island, Co. Mayo; as in appearance they are very like the American rock. As yet neither of these have been tested for nickel.

Magnetic pyrites (*pyrrhotite*) crystals that occur at Barnesbeg, Co. Donegal, were found by Scott to have traces of nickel and cobalt.]

TITANIUM.

[Titanium is rare in Ireland, or has not been recorded. Specimens of *rutilite*, or *rutile*, the native oxide, have been found at Cushanacurragh, near Burrischoole, to the north-east of Clew Bay, Co. Mayo. In the Co. Donegal, Sir C. Giesecke records it as found in quartz pebbles, River Dale, and in mica slate, Arranmore, while Mr. J. V. Stewart, records it at Malinbeg and Ards. Recently bunches of small crystals have been found in Rosscuile, in the same county.]

MOLYBDENITE.

[This mineral appears to occur in rather considerable quantities disseminated in a wide endogenous granitic vein in the townland of Murvey, near Roundstone, Co. Galway (sheet 63). Elsewhere it does not appear to be recorded in quantity. Haughton found it in oligoclase veins at Garvany, near Castle Caldwell, Co. Fermanagh; while R. H. Scott found it in an elvan at Lough Laragh, near Glenties, and J. V. Stewart at Lough Anure, both in the Co. Donegal.]

ALUM AND COPPERAS.

[Alum shales frequently occur in the *Lower Coal Measures*, especially in the Province of Munster, while pyritous shales, suitable for the manufacture of copperas, are also found, especially in the *Upper Coal Measures*. To the pyritous shales special attention was directed by Kane, in 1844, but since then no one seems to have endeavoured to utilize them. Near Castleisland, Co. Kerry, are pyritous shales, called *Lapis Hibernicus Auctorum*; these at one time were used in the manufacture of copperas at Tralee.

Some few years ago Mr. Walter Jameson, of Glenarm, discovered an alum-clay (*alumyte*) in connexion with the lithomarge and iron ores of the Co. Antrim. This is at present worked in different places, but more especially near Ballintoy.

The alumyte must not be confounded with the French *Beauxyte*, or the German *Weheiryte*, both of which are ferriferous, and in aspect more or less similar to some of the varieties of the Antrim lithomarge and bole. The lithomarge and bole have not as yet been worked for alum; yet they seem to be allied to the alumyte, the latter appearing as if it was a secondary product; having been at first lithomarge, out of which the iron was leached by the associated lignyte, as the alumyte is always accompanied by the latter.—[See *County History*.]

SALT AND GYPSUM.

[In Ireland salt and gypsum are only found in the Triassic rocks of two counties, and are more or less associated. In all the sinkings for salt, although not in the borings, gypsum has been found; but in different places the latter occurs without salt.]

COUNTIES.	No. of Ordinance Sheet.	LOCALITIES.	REMARKS.
Antrim.	20	Cushendall.	Near to . . — <i>Gypsum</i> .—Found in the "Keuper Marl."
"	41	Ballylig.	Three miles south-east of Larne.—A bore-hole was put down in 1839, while making trials for coal, to a depth of 174 feet; at 150 feet <i>Salt Measure</i> was met, but the trial was abandoned before it was proved if a good bed of salt existed.
"	53	Eden.	On Belfast Lough. A <i>Salt Spring</i> at the village.
"	53	<i>Duncrus</i> .	Carrickfergus— <i>Salt and Gypsum</i> .—The <i>Salt Measures</i> , discovered in a trial in search of coal. In the old pit these are 162 feet in thickness, contain 110 feet of pure salt, and 13 of rock-salt; but in the new pit, 500 yards to the north, they are only about 100 feet thick; while to the S.W. of the old pit trials have been made without finding the <i>Salt Measures</i> . These data suggest that they are in a lenticular mass, or cake, of limited extent. The best salt-bed (88 feet thick) containing over 95 per cent. of pure salt.
"	63 & 67	<i>Mullaghecarton</i> , or <i>Multikartan</i> .	Lisburn, Valley of the Lagan— <i>Gypsum</i> .—Recorded by Ruttly in his <i>Natural History of Dublin</i> , 1772. <i>Gypsum</i> is known to exist in different places in the valley.
Tyrone.	30	Coagh.	S.S.W. of . . —In a pit sunk at the south side of the Ballinderry River thin seams, or beds, of fibrous <i>gypsum</i> occur in a red and green marl, 15 feet thick.
Monaghan.	31 & 34	Derrynasrobe.	Carrickmacross.—A cake of <i>gypsum</i> . In one place upwards of 60 feet thick. Was manufactured at Knocknacran into Plaster of Paris until the works were burnt down prior to 1870.
"	31	Knocknacran.	
Meath.	2	<i>Raloaghan</i> .	S.E. of Kingscourt— <i>Gypsum</i> .—Proved by borings in the first townland; raised in the two others.
"	4	<i>Newcastle</i> .	
"	—	<i>Keernaghan</i> .	

APATITE.

[Apatite in quantity has not as yet been recorded in Ireland; but as some of the rocks are very similar to those associated with the apatite in Canada, especially some of the West Galway rocks, it may yet be found.]

COUNTIES.	N. of County Sheet.	LOCALITIES.	REMARKS.
Antrim.	—	—	In the Lias of the east coast some nodules (<i>coprolites</i>) have been found, but not in quantity.
Donegal.	27	Craanford.	Millford— <i>Ordovician</i> .—A poor apatitic limestone.
„	37	Carn High.	Rathmelton— <i>Ordovician</i> .—A slightly apatitic limestone.
„	35	Barnes, Upper and Lower.	Kilmacrenan— <i>Metamorphic Cambrian</i> (?) Scott records having found traces of apatite in these townlands.
Galway (?) Tyrone (?)	— —	West, or Yar-connaught. Slieve Gallion District.	<i>Ordovician</i> (?) or <i>Cambrian</i> (?)—Some of the rocks in both these areas are very similar to those, that in Canada, are associated with the apatite.

STEATITE AND PYROPHYLLITE.

[Steatite and pyrophyllite generally occur more or less deteriorated as the rocks,—*steatyte* (soapstone), and *pyrophyllite* (camstone). They are very much confused in the records, both nearly invariably being called by the first name. *Steatyte* is for the most part made up of silicate of magnesia, and nearly invariably occurs as an adjunct of the intrusive rocks; although in some cases a "fault rock," made up of the *debris* of intrusive rocks may become a *steatyte*. They may pass into talcylite. The rock *pyrophyllite*, is for the most part made up of silicate of alumina, and nearly always occurs in beds, as if it was a methyloitic sedimentary tuffose rock. Nearly invariably it has a fibrous or elongated prismatic structure, and often passes into sericyte, or anhydrous micalyte.

The largest and most valuable recorded Irish localities for *steatyte* are in the Co. Mayo; while *pyrophyllite* is more known in Donegal than any other country. Beds of *steatitic* clay, or "Fuller's earth" are found in different places, and formerly were much used for abstracting grease from woollen articles, while in the Co. Galway they are still used for that purpose. *Pyrophyllite* has been used in the manufacture of lubricators, but as it contains about 30 units of alumina, it might possibly also be utilized in the manufacture of alum and alumina. Neither *steatyte* nor *pyrophyllite* have been carefully looked for or recorded. The following list, therefore, may fall considerably short of the number of places in which they occur.]

COUNTIES.	No. of Ordnance Sheet.	LOCALITIES.	REMARKS.
Antrim.	47	Gobbin's Rock, Island Magee.	<i>Eocene</i> (?)— <i>Steatyte</i> .—Formerly extensively used for French chalk.
Cork.	128	S.W. of Dunboy.	Castletown, Bearhaven— <i>Carboniferous Slate</i> .—These, especially the first, appear to be dykes; the latter is cupriferous. Both seem to be more of the nature of <i>pyrophyllite</i> than <i>steatyte</i> ; but as yet have not been tested.
"	127	Pulleen Harbour.	
Donegal.	37	Meenrea.	West of Rathmullen— <i>Ordovician</i> (?)—A bed of <i>pyrophyllite</i> .
"	17	Kildrummon.	South of . . — <i>Ordovician</i> .—The back of a bed of <i>pyrophyllite</i> exposed at the shore.
"	45	Cloony.	N.W. and N. of Rathmelton— <i>Ordovician</i> (?)—A bed or beds of <i>pyrophyllite</i> : worked along the back, or outcrop, for clay to be used, as hearths.
"	48	Carn.	
"	44	Clonkilty.	Westward of Kilmacrenan — <i>Ordovician</i> (?)—In several places in the hills. In general the <i>pyrophyllite</i> of the Co. Donegal is called <i>camstone</i> or <i>cambstone</i> . It has been quarried for architectural purposes.—See Wilkinson's <i>Practical Geology</i> .
"	44	Cottian.	

COUNTIES.	No. of Ordovician Sheet.	LOCALITIES.	REMARKS.
Donegal.	44	<i>Carrowtrama.</i>	West of Loughakib, Church Hill (Gartan)— <i>Cambrian</i> .—A bed of pyrophyllite. Mined for some years profitably, and sold in the market under the trade-name of "steatyte."
"	56	<i>Orahy Head.</i>	Dungloe— <i>Ordovician</i> (?)—Beds of pyrophyllite(?): for some time mined to be used in the manufacture of lubricators.
"	53	<i>Cabra Giebs.</i>	S.E. of Churchtown— <i>Ordovician</i> .—Pyrophyllite bed: seems to have been worked in old times, but no opening has been made for many years. Adjoining the old working is a heap of peculiar saucer-shaped pieces of slag.
"	79	<i>Gibbetown.</i>	W.N.W. of Castlefinn— <i>Ordovician</i> .—Pyrophyllite, or "camstone," has been raised for years; in old times for architectural purposes, and more recently solely for slabs for furnaces. Camstone veins also occur in the country to the northward, between Castlefinn and Letterkenny, that appear to have been used for farm purposes.
Galway.	25	<i>Kilmeelickin.</i>	Maumbridge— <i>Ordovician</i> .—Tumblers and fragments of steatyte(?); the source not proved. In other places in this county small veins of steatyte are recorded as associated with the ophytes, but no considerable accumulation is recorded.
Mayo.	37, &c.	<i>Croagh Patrick Range.</i>	Westport— <i>Ordovician</i> .—Small accumulations and veins of steatyte, associated with the ophyte that forms the long tract (the largest in Ireland) extending from the N.W. slopes by Croagh Patrick to eastward of Westport. No large or pure vein, or pocket, is recorded.
"	65	<i>Claggan.</i>	Achill Island— <i>Ordovician</i> .—An irregular bunch, or "pocket-vein," of steatyte. A portion is crystalline and very pure: has been worked to a small extent.

COUNTIES.	No. of Ordinance Sheet	LOCALITIES.	REMARKS.
Mayo.	107	Lugaloughaun.	Westport— <i>Ordovician</i> .—Pockets and veins of steatyte, associated with ophiolyte: first records by <i>Warren</i> . [<i>Geological Survey Mem. Es. Sheets</i> 83 and 84, page 49.]
„	106	Glencullian.	(Doolough) <i>Louisburgh—Ordovician</i> .—A dyke of mottled-green steatyte.
„	106	<i>Clegganadodda</i> .	<i>Louisburgh—Ordovician</i> .—A large yellowish mass, associated with an intrude of felstone; appears to be in part pyrophyllite, and in part steatyte.
„	114	<i>West Quarter</i> .	<i>Bofin Island—Ordovician</i> .—This island, as also <i>Shark</i> , lie off the coast of Galway, although in the Co. Mayo. A very important and large mass of steatyte, having in places very pure veins and pockets: has been worked a little.
„	114	N.W. Coast.	<i>Shark Island—Ordovician</i> .—A large mass of steatyte; very similar to that on the opposite shore of <i>Bofin</i> .
Wicklow.	39	Killahurla.	<i>Woodenbridge—Ordovician</i> .—Dykes of an orange or yellow steatyte. In this county, also in Wexford and Waterford, associated with the basic eruptive rocks, are small veins of steatyte, but none of those recorded are of a size requiring a special notice.
„	17	<i>Glenmacnass</i> .	S.E. portion— <i>Metamorphic Cambrian(?) Pyrophyllite (camstone)</i> ; formerly (1837) worked for chimney-pieces, &c. The stone when first raised was quite soft, but after being cut rapidly hardened.

NOTE.—Steatite and Pyrophyllite in this list are minerals, while Steatyte and Pyrophyllite are rock masses: that is, the minerals incorporated with impurities, as found forming beds or veins.

FLUOR or FLUORSPAR.

Fluor or Fluorspar should be mentioned among Irish minerals, being an important flux in the reduction of iron. Unfortunately its value, until recent years, was not generally known, and the places in which it has been found are only sparingly recorded; while a search for it has not been made. Among the records, we find it mentioned as occurring in several of the lead mines in the Co. Clare; at Minna and Inverrin Mines, Co. Galway, of a violet colour; and in the same county, at Glengoola, of pale yellowish-green or bluish colour; while in the Mines of Glendalough, Co. Wicklow, it was found both crystalline and massive. None of the records, however, state that, as yet, it has been found in sufficient quantities to be of commercial value.

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PART II.—BRIEF COUNTY HISTORIES.

THESE County Histories are placed in alphabetical order. In Part I., THE LISTS OF THE MINERAL LOCALITIES—places where *salt, gypsum, steatite, pyrophyllite*, and other useful products occur—are given, as the workings to obtain them are included under the general name of “Mines,” although legitimately speaking they do not belong to “Metal Mining.” On the same principle the localities for *coal* ought to have been mentioned, more especially as the coals are more or less connected with clay-iron-stone. Coal workings, however, are so important that universally they have been separated from Metal Mining, and have been given a distinct place of their own. Nevertheless, in these County Histories, it seems impossible to pass them over; they will, therefore, be briefly referred to, in the Counties in which they occur, in connexion with the iron-ores, the working of both being more or less connected. The Irish coals are of Eocene (?), Carboniferous, Ordovician, and perhaps of Cambrian ages.

Some of the statements made hereafter have not been verified, and in such cases the authorities will be mentioned. Much information can be learned from Lewis’s *Topographical Dictionary*. The name of the writer of the geological descriptions is not given; but, as far as I have been able to test them, they appear trustworthy. Unverified statements, however, will be given on Lewis’s authority.¹

The English writers on Ireland, such as Spencer, Raleigh, Ledwich, Boate, and others, insinuate, or positively state, that the Irish, before the English came to the country, were perfectly incapable of finding or working minerals. This, however, the researches of the Antiquarian have proved to be perfectly incorrect, as the early Irish were eminent workers in gold, silver, brass, and, I believe, iron. Their trade degenerated, and perhaps altogether

¹ From the style adopted in these descriptions, I would suggest that Weaver was probably the writer.

ceased, during the internal wars before and after the advent of Strongbow and his mercenary companions. The statements of these writers as to early mining cannot, therefore, be relied on, although they may be quoted in reference to works that were in existence when they wrote.

In the early times gold and silver were recognized productions, especially gold, as pointed out in the Paper by the late Gerrard A. Kinahan, *On the mode of Occurrence and Winning of Gold in Ireland* (*Proc.*, R. D. S., vol. iii., pt. v.). The English, prior to 1640, discovered and worked three silver-lead-ore veins in Antrim, Sligo, and Tipperary. The site of the mine in Antrim is now unknown, but probably it was somewhere in the Ballycastle Metamorphic rocks district. The Sligo mine was in Coney Island, but it also appears to be now unknown, or to be given a different name; while that in Tipperary was the Silvermines near Nenagh. The last, although claimed as an English discovery, had previously been worked by the Irish.

Boate (1641) would have us believe that the English were the first to smelt and work iron. Chioester, however, in his report (1609), states he found, in Ulster, smiths at work, making steel out of the native iron, which they wrought much more easily than it could be made in England. The English and Scotch however, who came over after his report, developed an extensive trade; which seems to have been at its maximum at the time of the rising in 1641.

The Iron-works were of different kinds: some Iron-masters had furnaces and mills; others, especially in Ulster, smelted the iron in bloomeries at the places where the timber was most plenty; while others had their furnaces near the coast of Ulster, Connaught, and Munster, importing most of the ore from England and Scotland. The principal Iron-masters at this time, whose names are recorded, were—Lord Cork, furnaces, mills, and mines in divers places in *Munster*; Wandsworth (Wandesford), furnaces, mills, foundry, and mines, *Carlow* and *Kilkenny*; Sir Charles Coot (Coote), mines and works, *Queen's County*, *Leitrim*, and *Roscommon*; Lord Londonderry, mines and works, *Queen's County*; Lord Ely and Pigott,¹

¹ Pigott's works may have been in the Queen's County.—(See description, King's County, page 90).

mines and works, *King's County*; Sir John Dunbar and Sir Leonard Bleverhasset (Blennerhasset), mines and works, *Fermanagh*; London Company, mines and works, *Clare, Limerick* (?); Sir William Petty, works, *Kerry*; Lord Stafford, mines and works, *Wicklow* and *Carlow* (?); Rennie, mines and works, *Londonderry* and *Tyrone*; and Sir Walter Raleigh, mines and works, *Waterford*.

Boate states that the large furnaces and works, except those on the coast-line, were each built convenient to a mine; while the bloomeries were moved from place to place, where the fuel was most abundant. We may therefore suppose that formerly iron-mines existed close to most of the above-mentioned furnaces.

The majority of these iron-works were destroyed in 1641, during the troubled times; but many of them were afterwards reinstated, while other works and mines were also started.

Later in Wicklow an Englishman of the name of Bacon erected works at Shillelagh, and introduced the importation of pig-iron from Wales. These works were carried on by his son-in-law Cholmondeley, who changed his name to Chamney, and the latter, or his descendants, are said at one time to have had fifty-two works, between founderies, mills, furnaces, and bloomeries, in the counties Wicklow, Wexford, and Carlow; the Chamneys, besides importing ore, worked mines in different places. In Cork, at Coomhola and Roaring Water, were the mines of the Whites. In Clare and Galway, the Bradys of Raheen, the Burkes of Marble Hill, and others, opened new mines and established works; while in Mayo, the Gildeas of Port Royal were large Iron-masters. There were also elsewhere mines and works, that sprung up, to die out subsequently, as the forests were gradually exhausted. At the present time the Bog-iron-ore is exported from Donegal, Londonderry, and elsewhere, to be used in the purification of gas. The raw product, in itself, is of little value; but after it has taken up the gas impurities the "Gas Wastes," as it is called, is so valuable that the exporters find it profitable to supply, free of cost, the Ore, on the condition that they are returned all the "Gas Wastes." The latter are used for the manufacture of very pure sulphuric acid and brown paint (see page 40).

Coal must have been worked at a very early time in Antrim,¹ but the English were the first to discover and work it elsewhere. Between 1630 and 1640 coal was discovered by Christopher Wandesford at Idrone in the Co. Carlow, while rising iron-ore; subsequently (1728) it was looked for and found in Coolbawn Hill, Co. Kilkenny; but it was not till later, when the woods began to be exhausted, that elsewhere it was more generally looked for and worked.

The geological sketches at the beginning of each county description are necessarily very brief, and many important details have had to be quite ignored.

ANTRIM.

The rocks of this county belong to the *Cainozoic*, *Mesozoic*, and *Palaeozoic Periods*; but the exact groups to which the first and last belong have not been determined. The oldest rocks are metamorphosed, and may possibly be of *Ordovician age*, but probably are *Cambrian*. Next to them are rocks belonging to the *Calp* group of the Carboniferous, while the Mesozoic is represented by portions of the *Trias*, *Jurassic*, and *Cretaceous*. The Cainozoic consists nearly solely of sheets of Dolomite and their adjuncts, and in the latter are plant remains, that, some say, indicate a *Miocene*, others, an *Eocene age*. The mines worked have been principally for coal and iron, while at the present time alum-clay (*alumyte*) is also a source of industry.

In the Eocene (?) are beds, or portion of beds, of coal (*lignyte*), *alumyte*, *litomarge* (*ferriferous clay*), *bole* (*aluminous limonite*), and iron-ore (*limonite* and *magnetic*); with *steatyte*, near the Gobbins Island Magee. Various attempts have been made to work the *lignyte* profitably, but all seem to have failed. In the *alumyte* works (although in some of the mines there is a considerable thickness of *lignyte*) it is considered perfectly valueless, and is run out on to the attals (*spoils*, or *waste heaps*), or is used as filling stuff in the old workings (*stulls*).

The probable origin of the *alumyte* (alum-clay) has been given in a Paper on the "Irish Crystalline Irish-ores," *Scien. Proc.*,

¹ The coal mines in Antrim seem to have been the oldest in England, Scotland, or Ireland.—(See Co. Antrim, page 68.)

R. D. S., vol. iv., 1884, p. 311, and need not be here re-given. At the present time only this clay is worked for the manufacture of alum, although the associated lithomarge and bole are very similar in aspect to the ferriferous varieties of the French and German clays (*bauxyte* and *woehelynte*). It would, therefore, appear expedient that the bole and lithomarge should be more minutely tested, especially the light-coloured varieties of the latter.

The mining in the alum-clay (*alumyte*) is quite of recent date. Its value was first discovered by Mr. Walter Jemerson in 1873, who began to work it in 1874: since then the trade has largely developed.

The following are analyses of the alumyte, bauxyte, and woehelynte, procured through Mr. Jemerson:—

	<i>Alumyte.</i> Glenarm.	<i>Alumyte.</i> Ballintoy.	<i>Bauxyte.</i> Dahm's.	<i>Bauxyte.</i> Margeillec.	<i>Woehelynte.</i>
Alumina, . . .	42.45	52.37	63.19	67.83	57.04
Peroxide of Iron,	1.54	1.29	3.72	00.47	1.08
Lime,	0.46	0.48	—	—	—
Magnesia, . . .	Trace.	Trace.	—	—	—
Potash and Soda,	0.04	0.06	—	—	—
Silica,	27.50	13.15	11.47	10.64	19.60
Titanic Acid, .	9.40	5.20	—	—	—
Sulphuric Acid, .	0.08	0.35	—	—	—
Phosphoric Acid,	None.	None.	—	—	—
Organic Matter, .	Trace.	Trace.	—	—	—
Combined Water,	18.53	27.13	16.32	15.80	17.46
	100.00	100.03	—	—	—

The analysis of the alumyte was made by John Pattison, Newcastle-on-Tyne. In the French and German analyses the alumina is both hydrated and anhydrous. As sulphuric acid, in the process of alum making, only extracts the hydrated alumina;

in the Continental minerals, by all known processes, there is a loss of from 6 to 8 per cent. that cannot be abstracted; on this account the Irish clays compare much more favourably with the Continental than the Table suggests. Many of the bauxytes and woeheinytes contain much more iron than the above, iron having been made from a variety of the latter. Of bauxyte Dana gives three analyses; containing of iron respectively, 27·6, 3·0, and 34·9 per cent. The Irish clays contain much more silica than is found in the French or German. The bauxyte, however, which gave 3·0 Iron is white in colour and gives 21·7 of silica.

The Canizoic (*Eocene*?) iron-ore trade is also of recent development. In 1609 Chichester mentions ore, while in 1683 Dobbs suggested that it existed in Island Magee; but it would appear that it was not generally known before 1861, when Dr. Ritchie specially directed public attention to those iron-ores. Afterwards they were successfully worked, until the slack in the iron trade, since which time, although not as successful as previously, there is a sufficient demand for the ore to keep some of the workings still going.¹ The occurrence of the pisolitic-ore is peculiar; for, although it appears as if bedded, its genesis probably was long subsequent to the formation of the associated rocks. The pisolitic iron-ores fill horizontal shrinkage fissures, the accumulations having characters more or less analogous to those of standing lodes.—(See *Scien. Proc.*, R. D. S., vol. iv., 1884, p. 312.)

The steatite at the path to the Gobbins Island Magee was formerly worked as “French chalk.”

In places the doleryte is decomposed into a rich ochre. Of ochre found at Mr. M'Arthurs, near Ballymena, Apjohn writes: “The siliceous of the basaltic ochre is at present in a state of extreme division; and from this circumstance, and the great depth and beauty of its colour, it appears well suited to the purpose of a red paint for gates, railings, and other descriptions of outdoor work.

The Jurassic beds (*Lias*) are very sparingly represented; but in them are apatitic nodules (*phosphates*). These, however, have not been found in sufficient quantity to be utilized.

¹ Quite recently (1885) arrangements have been made to work an accumulation found in Rathlin Island.

In the Trias, near Cushendall ; in the Forth River Valley ; in the Woodburn Valley, between Kilroot and Whitehead ; and in the Valley of the Lagan, gypsum occurs in the marls ; but although the veins in places are numerous, none that are known are thick enough to pay for working.

The Salt mines at Duncrue are of recent date, the salt having been discovered in 1850 while boring in search of coal. As mentioned in Part I., page 56, the *Salt Measures* may extend eastward towards Eden, and northward towards Larne, as saline wells are found in those directions.

In remote and recent years there have been workings for coal and iron in the BALLYCASTLE COAL-FIELD. The rocks are commonly called Coal Measure ; but correctly they are a portion of the Calp division of the Carboniferous limestone : they are, however, the equivalents of the so-called "Lower Coal Measures" of Scotland. The earliest works were during the time that "stone implements" were in use, as about 1770, during the mining operation, then in progress, old galleries, having in them wicker-work baskets and stone implements, were broken into. In recent years the Macgildowneys were those who worked the coals, the royalties at the time belonging to the Boyds.

At what time, or by whom, the ancient galleries were driven is now unknown ; but it is evident the industry ceased and was forgotten. In 1700, Ballycastle¹ was quite a poor place, containing some sixty-two house-holdings, and extending over an area of about three acres. But about the year 1784 it had advanced, and became a prosperous town, having its iron works of various kinds, its manufactures of salt and soap, its weaving and bleaching establishments, its tanyards, its glass-house, and brewery. The enumeration of these is in part foreign to the present inquiry ; but as they were in a great measure adjuncts of the mining operation, it may be allowable to refer to them.

The prosperity of the place was in a great measure due to the energy of Hugh Boyd, the proprietor, and it began to decline about 1670 or 1680, after his death, the decline being aided by

¹ This place got its present name from the castle built in 1609 by Randolph, Earl of Antrim. Correctly the coal and iron works should be called the Culfieghtrim collieries ; but this name has been quite superseded by that of Ballycastle.

the London Society (Londonderry) having successfully opposed a grant of money to improve the port.

It may be mentioned that the glass industry seems to have been of a very ancient date, possibly prehistoric, as some authorities suggest that this was one of the places in which the ancient glass beads and such like were made. It was induced by the excellent sand of the vicinity, due to the weathering and washing of the sandstones of Carboniferous age. The glass trade, which was principally an export one to Scotland, gradually declined as the native coal increased in price, and seems to have finally ceased in 1850, or thereabouts, when the glass-house was destroyed by lightning.

The higher coals, or those above the level of the sea, are worked out. There are, however, two coals, called the "Sea-coals," below the sea level, still unwrought; which have been estimated to contain about 18,000,000 tons of coal; but as far as trials have been made they are unprofitable, on account of the drainage of the sea into the workings: very little, therefore (if any), of this coal can be profitably raised.

Mr. Knowles of Ballymena has found prehistoric beads made of *soisite*, or *jade de Saussure* (saussurite), in the Æolian sands in places along the coast-line in connexion with Kitchen middens and such like early traces of man; while Mr. M'Henry has discovered small veins of similar jade in the metamorphic Cambrians(?).

In, or associated with, the older rocks (*Metamorphosed Cambrians?*) gold is said to have been found in Glendun, near Cushendun; and in 1825 the Glenarm and Antrim Mining Association proposed to work the gravels of the river. This Company are also reported to have found in Slieve-an-orra and neighbouring hills, traces of copper and lead; but the extent to which they carried their researches in quest of these minerals is uncertain, as there are not any published records of the places where these minerals were found.

As already stated, in this county was situated one of the three lead mines discovered by the English prior to the rising of 1641; whereabouts it was situated Boate does not state, but he gives a most glowing description of it, stating: "for as much as with every thirty pounds of lead it yielded a pound of pure silver." At the present time it is quite unknown.

In the National Museum, Leinster House, Dublin, are some fine specimens of *Onyx*, said to have come from Rathlin Island.

ARMAGH.

The major portion of this area is occupied by *Ordovicians* in part metamorphosed with which to the S. E. are associated *Granite* and allied rocks. These to the N. W. are succeeded by *Carboniferous* limestone, while the latter, at the N. W. of the county, are overlaid by *Triassic* sandstone or marl, and to the N. E. by the *Tertiary* or *Cainozoic* rocks or the *Lough Neagh* beds. Some of the rocks near Armagh and to the N. E. at Benburb have been said to be *Permian*: their position and fossils, however, seem to prove this conjecture to be erroneous.

The recorded minerals occur nearly solely in the *Ordovicians* or the associated *Granite* and allied rocks. The principal mineral in the lodes was lead, but copper occurred in the veins at Jerret's Pass, near Newry, and Tullydonnell, near Crossmaglen. Griffith records an ancient mine at Ballymore, near Poyntzpass, but states its "exact position is not ascertained."

Lewis reports antimony as having been "found in a few spots."

Westward of Slieve Gallion in the western slopes of the hill near Larkin's mill, and not far from the edge of the *Granite*, either *Steatyte* or *Pyrophyllite*, probably the latter, has been found.

CARLOW.

The major portion of the area, included within the limits of Carlow, is occupied by *Granite*, a part of the Leinster range. To the extreme S. W. of the county is a small tract of *Coal Measure* a portion of the KILKENNY COAL-FIELD, which lies on the *Carboniferous* limestone of the valley of the Barrow, the latter overlapping the *Granite*. These limestones are supposed to lie direct on the *Granite*; but a few small outliers of *Carboniferous Sandstone* have been found, which may suggest that elsewhere rocks of this class intervene, but are unknown, being obliterated by the envelope of Drift.

Farther northward, in the Co. Kildare, Metamorphic rocks (*Ordovicians*) intervene between the Granite and the Carboniferous rocks, but they do not extend southward into the Co. Carlow; to the eastward of the range, however, at Clonegall and Newtownbarry a tongue of these rocks extends from the Co. Wexford into this county.

This county does not appear in Griffith's lists; but in the Coal Measure there are some seams and nodular beds of clay-iron stone that were mined between 1600 and 1641 by Christopher Wandsworth (Wandesford); who had also works, including a foundry for ordnance, at Idrone.—(See *Leinster Coal-field, Co. Kilkenny*). In latter years iron was raised near Shillelagh, Co. Wicklow, and probably also in this county.

Except the clay-iron stone there are no authentic records of minerals or veins. Gold, indeed, is said to have been found not many years ago in one of the valleys N. E. of Graiguenamanagh: this has not, however, been authenticated. Lead is also said to have been found in one of the same valleys, and some trials were made unsuccessfully. It may be pointed out that these trials were injudicious, and not in the places where lodes would probably be found.

CAVAN.

About Lough Sheelin, at the south of the county, and extending in from Westmeath, is the edge of the great central tract of *Carboniferous Limestone*, while in the vicinity of Stradone there is a small outlier. The north-western portion of the area is solely occupied by Carboniferous rocks; in places there being *Coal Measure*; as in a small tract between Ballyconnell and Swanlinbar; and in the hill country, to the N. W., of which Cuilcagh, partly in Leitrim, is the highest summit. At Cavan there is a limited tract of *Carboniferous Sandstone*, and S. W. of it is an intrude of *Granite*, while the rest of the area is occupied by *Ordovicians*.

The mountain tract to the N. W. is a portion of the CONNAUGHT COAL-FIELD; including portions of the counties Cavan and Fermanagh (*Province of Ulster*), with parts of Sligo, Leitrim, and Roscommon (*Province of Connaught*). As all are part of the one field, they may here be described together.

In old times, but more especially in the sixteenth and seventeenth centuries,¹ there was extensive mining, smelting, and milling, of iron, which lasted till the woods were exhausted, the fuel being wood-charcoal. As the woods disappeared the fires were put out, the last extinguished being Drumshambo, Co. Leitrim, in 1765. Shortly afterwards, in 1788, the three brothers O'Reilly tried to revive the industry, and smelt the iron ore with the coal—the first attempt of the kind in Ireland. They erected a furnace and mills at Arigna, Co. Roscommon, and sent into the market some excellent pig and bar iron; the coal being procured at the Rover and Aughabehy collieries; respectively, about one and three miles distant. The adventure, however, did not prove successful on account of English competition; and after passing through the hands of other speculators the enterprise was abandoned in 1808.

In 1818 Griffith made a favourable report of the iron ore of the district: this, coupled with his statement before a Committee of the House of Commons in 1824, induced the Irish, the Hibernian, and the Arigna Companies to take setts for the working of coal and iron in the Co. Roscommon. The first and second had their mining setts in the Cashel Mountain, or Slieve Curkagh, the range of hills north of the Arigna River; while the workings and works of the Arigna Company were to the southward of that river in the Bracklieve range; but now more generally called the Arigna Mountain, after the name of the site of the furnace and mills. Practically the Hibernian Company did no work, the report of their surveyor being considered unfavourable. The Irish Company opened some pits, the largest being at Tullytawen, where the coal for a time gave a profit; but the most extensive works were those of the Arigna Company.

The original works of the O'Reillys at Arigna appear eventually to have become the property of the Latouches of Dublin, because from them, in 1824, the new Company obtained a lease of the works and mines. They commenced work with a large staff of

¹ Before the rising in 1641, Sir Charles Coote, besides his Iron Works at Mount-rath, Queen's County, had others in the counties of Leitrim and Roscommon. The Leitrim Works may have been at Creevelea, and those of Roscommon were somewhere in the valley of the Arigna, all these works were burnt in 1641.

English artizans and engineers, and from November, 1825, to May, 1826, the works were prosperous, some 250 tons of iron being manufactured at a cost of £8 4s. per ton. Then unfortunately, through some mismanagement, the furnace was choked; which led to an expensive Chancery suit, lasting for ten years, when it was decided in favour of Mr. Flattery, who recommenced the smelting and manufacture of iron in 1836. Flattery worked for some years very spiritedly, opening, besides O'Reilly's collieries, another at Gubberudda, where the coal was of a better quality. But eventually he could not compete with the English and other iron-workers, and his fires had to be put out. Since Flattery's time iron has not been smelted in the district, but the coal has been worked profitably for a local trade.

In the Slieve-an-ierin district, to the east of Lough Allen, counties Leitrim and Cavan, the clay-iron stone is richer than in Co. Roscommon, and in former times, while the forest lasted, was extensively mined and worked, the name of the hill *anglice* "mountain of iron," suggesting pre-historic workings. Since the Drumshambo furnace was put out, in 1765, no iron has been smelted, while very little work has been done in the coal, apparently on account of the great quantity of peat fuel. According to Boate, iron was worked, in 1650, "in a place called Doubally," Co. Cavan, and "upon Lough Erne," Co. Fermanagh.

To the N. W. of the Co. Leitrim, in the barony of Drumahaire, the clay-iron-stone was formerly also extensively raised. Of this a considerable quantity was carried to Ballynakill, south-east of Collooney, and to a furnace near Ballysodare, both in the Co. Sligo, to be mixed with other ores and smelted. It was also smelted at the Creevalea Iron Works, townland of Gowlaun. In this townland, and the adjoining one of Tullynamoyle, there are various beds, or nodular beds, of clay-iron-stone, the richest, as pointed out by Griffith and Jukes, being one about eleven inches high, which is as good, or perhaps better, than any of the seams in Slieve-an-ieran. According to the record, Sir C. Coote appears to have had works here in 1640, while the last furnace for smelting iron with wood-charcoal, was extinguished in 1768. The works, however, were resumed, in 1852, by a Mr. Currie, who, laid out large sums in blast-furnaces, kilns, tramways, engines, and workmen's houses; but became bankrupt in 1854. Afterwards the works were rented by

Mr. Potts of Dublin, who smelted a little iron with peat charcoal; they, however, were abandoned in 1858-59.

In this field the amount of clay-iron-stone is considerable: some of it, however, is inferior. Of coal there cannot be much; perhaps some 10,000,000 tons, of which only a portion could be economically wrought, especially during the present low price of coal and high rate of wages. The coal in part is gaseous.

Other minerals in Co. Cavan occur in veins in the *Ordovicians*, such as copper in Farnham, near Cavan, and lead near Cootehill, Shercock, and Ballyconnell.

In the *Ordovicians* of Kill, near Kilnaleck (*sheet 37*), there is a bed of anthracyte. This, when discovered in 1854, was sunk on, and according to Dr. Whitty's report, was in one place four feet thick. This, however, appears to have been a local swelling of the bed, as elsewhere in the strike and in depth it was only a few inches wide. About two miles southward of Shercock are beds of anthracitic shales: these in bad winter, when fuel was scarce, have been worked for firing; they were, however, only a make-shift in the place of better, because at present they are of no commercial value. It is, however, possible that here, as in Canada, anthracitic and carbonaceous shales may point to underlying oil or gas cisterns. This seems worthy of further research.

CLARE.

The rocks of this county belong to the *Carboniferous* and *Ordovician* periods. Nearly half the western portion of the area is occupied by Coal Measures, the northern portions of the extensive WEST MUNSTER COAL-FIELD; while to the east, in the neighbourhood of Lough Derg, hills of Ordovician rocks protrude up through the Carboniferous.

In Munster, especially Limerick and Clare, between the *Calp* and *Fenestella* limestone (lithologically divisions of the Carboniferous rocks) leady lodes often occur; below the *Fenestella* limestone the lead is usually accompanied, more or less, with copper and sulphur ores. On both horizons the minerals do not occur in regular lodes, but in pockets and "shoots," which, when worked out, have no leaders to other deposits. Different, very rich pockets

have been found on both horizons, which were remunerative to the first adventurers, but more or less disastrous to their successors who have attempted to follow what they supposed to be "leads." Pockets of this class are indicated by calcspar, associated with dolomitic sand. In the limestones of the *Burren type* numerous small veins of lead and zinc have been found, but none of them of promise; yet we learn from the records that, in the time of James the First, there was a "silver-mine" in the Burren, adjacent to O'Loughlin's Castle, now called Castletown, while there are misty records of much more ancient mines. Fluor or fluorspar was found in different mines, associated with the lead.

In the *Coal Measures*, near the Shannon, below the horizon of the lowest coal, some of the shale-beds are very rich in nodules of clay-iron stone. The coals in this county are of very little account. Near the Shannon, to the south, there are some thin beds, that were worked in old times along the outcrops, but as they are traced northward they thin, till eventually the horizons are only marked by fire-clays, with stems of *stigmaria*. The iron-ore beds also appear to become poorer as they are followed northward. In the old times the latter were worked to the southward, in the vicinity of the estuary of the Shannon. Some of this ore seems to have been smelted in the vicinity of the mines, but much of it was carried inland, or was sent up the Shannon by boats, to be mixed with Ordovician and other ores at the furnaces on Lough Derg or elsewhere. This clay-iron stone is mentioned as worked in 1650, while it was smelted and wrought by a London Company at furnaces and mills near the mines.

Iron ore in the Ordovician rocks was extensively raised in Glendree, westward of Feakle, also at Ballymahon and Bealkelly, near Tomgraney. East of Feakle, at the hamlet now called Furnace, are the remains of considerable works, apparently principally for smelting purposes; while the iron raised at the mines near Tomgraney is said to have been sent by boat, to be smelted and milled at the different furnaces and works between Mount Shannon, Clonrush, and Woodford, west of Lough Derg, Co. Galway. According to the records, three classes of ore appear to have been in use for mixing at the furnaces, and these, from Gerrard Boate's descriptions, were evidently the bog-iron-ore, the ore from the Ordovician rocks, and the clay-iron stone from the

south of the county and the Co. Limerick. These furnaces and mills were at work until the woods were exhausted; the last fire put out (Woodford), about the year 1750, belonged to the Burkes of Marble Hill.¹

In the *Ordovician* rocks in different places are found, besides the iron ore (limonite), small veins and indications of lead, sulphur-ore, copper, anthracite, plumbago, &c.; but up to the present time none of them have been worked very successfully.

CORK.

The rocks of the premier county of Ireland are both interesting and peculiar. North of the valley from Dingle Bay, Co. Kerry, to Dungarvan, Co. Waterford, there is one type of Carboniferous rocks, while south of that line there is another. In the north-west part of the county, in the Ballyhoura and Galtee Mountains, there is *Carboniferous Sandstone*, within the latter a small exposure of *Ordovicians*. Over the sandstone lies the *Carboniferous Limestone*, and on the latter *Coal Measure*, a part of the **WEST MUNSTER COAL-FIELD**.

But south of Dingle Bay and Dungarvan Valley the rocks have lithological characters, more or less peculiarly their own, which have lead to various classifications and nomenclature. The petrology, or the *geological relative positions*, of the different groups have been very successfully worked out by Griffith and Jukes; but to suit the present ideas their names require revision, or rather modification. In this area there is very little limestone, it only being found to the eastward, while elsewhere it is replaced by shales, slates, and grits (*Carboniferous Slate*); these towards the west are of considerable thickness, being much thicker than the Carboniferous

¹ In the *Geology of Ireland* (1878), chap. xxi., p. 352, and in other writings on the subject, I have suggested as probable that the last furnaces in which wood charcoal was used for smelting iron were those of Woodford in Galway and Port Royal in Mayo. Since then I find that the Port Royal works appear to have been in existence subsequent to those of Woodford; while in Leitrim and Sligo there were fires alight in 1765 and 1768, or nearly twenty years later than at Woodford. The fires at Shillelagh, Co. Wicklow, were put out a few years before Chamney's death, which took place in 1761. The Port Royal works seem, however, to have been more recent than those of Sligo and Leitrim, as, about the year 1860, the old mill was partly in existence, the forge anvil being still *in situ*.—(See Mayo, p. 94.)

Limestone of the Central plain. Under the Carboniferous Slate is the *Yellow Sandstone* (Griffith) or *Upper Old Red Sandstone* (Jukes): it graduating downwards into the *Devonian* or *Lower Old Red Sandstone*, and the latter into the *Glengariff Grits* (Jukes) or *Silurian* (Griffith). The equivalents of the groups, as nearly as possible, are as follows:—

CORK TYPE.	CENTRAL IRELAND TYPE.
4. <i>Carboniferous slate</i> , . . .	{ Carboniferous limestone and Lower limestone shales.
3. <i>Yellow sandstone</i> , . . .	Lower carboniferous sandstone.
2. { <i>Devonian</i> , or Lower Old Red Sandstone,	{ Lower Devonian (?) (England).
1. <i>Glengariff Grits</i> , . . .	Silurian.

The Glengariff Grits are evidently the representations of the upper beds of the Silurians of the Dingle promontory, Co. Kerry. The Devonian (*Lower Old Red Sandstone*) are in part the equivalent of the Lower Devonians of England. In Co. Cork they form a regular *unbroken passage* from the Carboniferous rocks down into the Silurian; but in Slieve Mish, Co. Kerry they are only in part represented, the lower strata being absent, while the higher ones lie direct, but unconformable, on the Dingle Silurian.¹ Elsewhere in Ireland, except, perhaps, the Fintona Mountains, counties Fermanagh and Tyrone, the Devonian rocks are not represented.

The Yellow Sandstone (*Upper Old Red Sandstone*)² is an im-

¹ In Slieve Mish, above the unconformability ("Inch or Park conglomerate"), and below the Lower Limestone Shales, there is a thickness of some 5000 feet of strata. These must represent part of the rocks (called by me Devonians) below the Carboniferous Slate, Co. Cork. This fact seems to be ignored in the proposed new classification of the Cork rocks.

² Jukes' names for the Cork rocks, *Upper and Lower Old Red Sandstone*, has been the cause of considerable controversy in the Mining Community, they apparently not understanding that they are petrological or group names, and do not specially refer to lithological characters, and that the rocks of the groups may be either argillaceous (*shales and slates*) or arenaceous (*sandstones*). In Jukes' groups, as a general rule, argillaceous rocks (*Killas* of the miner) are more prevalent in the Upper, and arenaceous rocks form the majority in the Lower. In the Yellow Sandstone, or *Upper Old Red*, of the Co. Cork most of the Copper veins occur, they not being of any value in the Lower Old Red.

portant group, as at its base are the *Metallic schists* and their associated copper lodes.

The above divisions appear to be the true natural grouping of the South Cork rocks. Of late another, of a lithological character, has been attempted; but both petrologically and palæontologically, and even in part lithologically, it is evidently incorrect.

In the extensive WEST MUNSTER COAL-FIELD, only in this county, have productive coals been found; while here they seem solely to occur in a narrow strip along the Blackwater valley. In this strip the coals stand at a high angle, and appear to be cut off in depth by nearly horizontal faults. On this account, unless an elaborate system of bore-holes were put down, it is perfectly impossible to even guess, at the quantity of unwrought coal. The coal (*anthracite*) is of two distinct qualities—hard and soft—the soft flakey kind, or *culm*, being greatly in excess of the hard and more valuable variety. The latter is very sulphurous, but gives a strong heat. These coals have been working continually for a century and a-half. According to the writings of Gerrard Boate and Smith, clay-iron stone appears to have been raised here, to mix with bog-iron and the Devonian ores, for smelting at the furnaces presently mentioned.

In the Carboniferous Limestone and Sandstones, only a few mineral lodes are recorded.

In the Devonians, however, in the seventeenth century there appears to have been a large iron industry. During the time Sir Walter Raleigh lived at Youghal, he was an iron-master, having mines and works in the Devonians, Co. Waterford; but it seems uncertain if he did any work in this county. Lord Cork, however, had works in divers places. Smith, writing in 1750, mentions Lord Cork's works at Araglin, near the eastern extremity of the county, and those of the Whites, at Coomhola near Glengariff, and Aghadown near Roaring-water bay. Boate, a century earlier (1652), states that Lord Cork's works were near Tullow Bridge, and the ores used were of three kinds—bog-iron ore, clay-iron stone, and limonite or hematite—the latter probably being raised in the Devonian rocks.

During the present century there has been considerable copper-mining, induced principally by Colonel Hall's discovery, in 1810, of a valuable lode at Allihies (*Berehaven Mines*). These lodes occur in

the *Metalliferous beds* at the junction of the Yellow Sandstone and the Devonian rocks, and whenever they passed out of the *Metalliferous beds*, either horizontally or in depth, they became valueless. Here the strata occurred advantageously, being in a half bowl, across which the lodes (*counter lodes*) ran both E. and W. and N. and S. Some of the continuations of the lodes at the surface are massive, but, unfortunately for the Mines, once they pass the limits they lose their copper. These lodes at the first produced large returns; but after 1860 they began to fall away, and now appear to be nearly valueless.¹

Elsewhere, in the south of the Co. Cork, there are a few *counter lodes*; but most of the copper and other lodes run more or less with the strike of the rocks, only cutting across the beds in depth. On this account they are not so productive; nor are they so continuous in depth; because, when going down, if they have to pass through one of the massive grits, they split up into strings, and nearly invariably die out. It has been suggested that if these massive grits were sunk through the lodes would again be found: this, however, seems improbable, because, in some of the cliff sections, it can be seen that such split-up veins do not again mass into one. Some of the so-called lodes are regular beds of killas, highly impregnated with grey copper ore. In different places rich pockets have been found close to the surface, while in depth the lode lost its minerals. As pointed out by Jukes, the copper is very widely disseminated in the rocks, and "it will be obvious that a large quantity of poor ore, easily accessible, may be more productive than rich ore, or even the metal itself, which is disseminated in small quantities, or in situations requiring great trouble and expense for its extraction." In this portion of Cork the lodes are very deceptive, and it "is a district where, perhaps more than others, requires great caution, as well as skill and prudence to mine with profit, and is a most delusive district to the speculator, from its containing so many of these specimens of rich ore, many of which have not indicated the existence of much more ore than was actually seen in the specimens."

In the *Metallic shales* of the Yellow Sandstone the prevailing

¹ On account of the Igneous rocks in the vicinity (*Cod's Head*, &c.) it is possible, if tried in depth, Tin might be found.

ores are yellow and grey copper; but when passing from these into the Carboniferous Slate, and also in the latter, the ore is principally lead. There are, however, associated with the copper ores, the ores of various other minerals (*see Lists*) enumerated in Part I.

A peculiar lode occurs at Glandore and at Rosscarbery. It is associated with a dyke of fault-rock, and has a back of iron ore—in the latter fissures formed, which are now filled with manganese ore. It has been worked both for the manganese and iron, but has not been proved in depth. Probably it is a coppery lode.

Within the last few years there has been a movement in favour of the West Cork mines, especially those in the Sheep Head promontory. Near Kilerohane, and north-eastward thereof, there have been workings on the large coppery sulphur-ore lodes, and on some of the bedded grey copper lodes. In these lodes there is a considerable quantity of arsenic ore (*arsenopyrite*), while in places the carbonate and oxides of copper occur, as profitable “backs” to the lodes.

There are in some localities large accumulations and veins of barytes, while the copper ores at Dhurode (*Carrigacat*) and Kilerohane (*Sheep Head*) are auriferous, also the grey copper ores of Lissaremig and Rooska are argentiferous. With the silver-copper there is also silver-lead, while in the old workings at Rooska they raised a considerable quantity of carbonate of iron (*Chalybite*), which still remains in the *attals*, or waste heaps.

Anthracite is stated to have been found at Twomilebridge and Strancally, near Youghal.

Very good amethysts have been found in places in the Devonians, and were formerly utilized.

DONEGAL.

The principal portion of this county is occupied by Granitic and Metamorphic rocks, they having in places on them small patches of *Carboniferous Sandstones, Shales, and Limestones*. The Metamorphic rocks, in 1884, were discovered by the late Gerrard A. Kinahan to belong to two Geological periods, the younger are Ordovicians, and the older *must be either Cambrians or Laurentians*.

It is absurd, and also ~~inconsistent~~ in ~~view~~ of the ~~very~~ ~~marked~~ boundaries, and call a ~~part~~ ~~of~~ ~~the~~ ~~country~~ ~~with~~ a ~~new~~ ~~boundary~~ ~~line~~ has been proposed. The ~~larger~~ ~~portion~~ ~~of~~ ~~the~~ ~~area~~ ~~is~~ ~~however~~ but associated is some ~~Macmillan~~ ~~area~~ ~~and~~ a considerable area of Granitic gneiss.

Since the beginning of the present century various ~~authorities~~ have published lists of ~~minerals~~: but ~~although~~ ~~several~~ ~~of~~ ~~a~~ many, only a few valuable ~~mines~~ ~~have~~ ~~been~~ ~~discovered~~. Some good silver-lead was found in the ~~Macmillan~~ ~~area~~ ~~near~~ Ballyshannon, and in ~~Macmillan~~ ~~area~~ ~~near~~ ~~the~~ south-westward of ~~Dungloe~~: ~~however~~ ~~there~~ ~~is~~ ~~no~~ ~~any~~ metal mines of note, ~~although~~ ~~it~~ ~~may~~ ~~be~~ ~~seen~~ ~~from~~ ~~the~~ ~~very~~ ~~very~~ looking indications. At ~~Carrickmacross~~ ~~near~~ ~~Ballyshannon~~ ~~there~~ is a lead lode with a "back" of iron and ~~marble~~ in the ~~carboniferous~~ Limestone: this was worked for the first time in 1840, and 30 tons of ore was shipped for ~~Ballyshannon~~ ~~to~~ ~~London~~ in the River Dee, by Messrs. Farnham and ~~Co.~~

Cainstone, or pyrophyllite, has been ~~found~~ ~~in~~ ~~a~~ ~~few~~ ~~places~~, and the harder varieties were formerly used for ~~sculptural~~ purposes, while the finer kinds have been ~~used~~ ~~and~~ ~~are~~ ~~now~~ into the market as *statyle*. Fair beds of ~~quartzite~~ ~~are~~ ~~found~~ ~~as~~ ~~having~~ ~~been~~ ~~found~~ ~~at~~ ~~Dungloe~~ ~~and~~ ~~near~~ ~~the~~ ~~mouth~~ ~~of~~ ~~Lough~~ ~~Swilly~~ while gold is said to have been ~~detected~~ ~~in~~ ~~a~~ ~~small~~ ~~quantity~~ ~~near~~ ~~the~~ ~~stream~~ ~~that~~ ~~flows~~ ~~from~~ ~~Lough~~ ~~Swilly~~ ~~near~~ ~~the~~ ~~mouth~~ ~~of~~ ~~Ballyshannon~~.

As long as the forests lasted iron was ~~largely~~ ~~used~~ ~~and~~ ~~the~~ remains of the bloomeries and ~~hills~~ ~~are~~ ~~found~~ ~~in~~ ~~different~~ ~~places~~. Some bog-iron, and perhaps other ~~minerals~~ ~~are~~ ~~now~~ ~~used~~ ~~and~~ ~~the~~ records state that large quantities of ~~iron~~ ~~were~~ ~~imported~~ ~~into~~ ~~the~~ country from Scotland and England. At the present time ~~there~~ is an export trade of bog-iron-ore, ~~as~~ ~~is~~ ~~used~~ ~~in~~ ~~the~~ ~~process~~ ~~of~~ ~~cleaning~~ ~~gas~~ (see page 40).

Very fair beryls occur in some of the ~~granitic~~ ~~gneiss~~ ~~near~~ ~~the~~ S.E. of Dungloe, at Doocharry, and ~~near~~ ~~the~~ ~~mouth~~ ~~of~~ ~~Lough~~ ~~Swilly~~ ~~near~~ ~~the~~ ~~mouth~~ ~~of~~ ~~Ballyshannon~~; while Giesecke reports having found ~~granitic~~ ~~gneiss~~ ~~near~~ ~~the~~ ~~mouth~~ ~~of~~ ~~Ballyshannon~~ at Crohy, in the same barony.

DOWN.

The area within the limits is nearly solely occupied by *Ordovicians*, which towards the south are in part metamorphosed, having associated with them Granitic rocks of different ages—*Ordovician*, *Triassic* (?), and *Eocene* (?). At the extreme south of the county, also in the neighbourhood of Castle Espie, N.W. of Strangford Lough, are very small tracts of *Carboniferous Limestones*. On the shore of Belfast Lough is a small exposure of dolomite, having fossils of *Permian* types; while in the valley of the Lagan, to the N.W. and W. of the county, the *Trias* is capped with *Cretaceous* and *Eocene* (?) rocks.

In the *Cainozoic* rocks are thin, valueless beds of lignite, and in the *Trias* gypsum, but in too thin veins to be valuable.

In the *Ordovicians* are numerous small veins and indications of lead and copper, but only in a few places have they been found rich enough to work. A few thin beds of anthracite have been noted in the vicinity of Strangford Lough.

In early times iron was mined in the Slieve Croob district; and a few years ago good hematite was discovered at Deehommed, south of Banbridge: this mine has still to be developed.

In exogenous veins in the *Triassic* (?) Granite of the Mourne Mountains topazes and beryls have been procured; the localities being the N.W. side of the small lake on Bingian, on Slieve Havila, and the Chimney Rock Hill.

DUBLIN.

In this county the prevailing rocks are *Carboniferous* of the *Calp* type. At Howth and Bray are small tracts of *Cambrians*. West of the latter is the N.E. extension of the Leinster Granite range, flanked westward by *Ordovicians*, in part metamorphic; while at Portrane and Balbriggan there are small exposures of *Ordovicians*.

The county is poor in mines, the lodes found, being principally lead and copper. In the Granite at Dalkey, tin is also recorded by Griffith.

Rich silver-lead, with silver, was found to the south of the county, at Ballycorus, and lead at Shankhill and Rathmichael, at the vicinity of the junction of the Granite and Metamorphic rocks. These lodes are worked out, but other lodes ought to occur elsewhere in the vicinity of the line of junction.

Gold in small quantities has been found in the Diluvium of some of the valleys in the Ordovician.

Beryls have been found in the neighbourhood of Killiney and Dalkey, in Glencullen, on the Three-Rock Mountain, and at Stillorgan.

FERMANAGH.

Westward of the valley of the Loughs Erne the rocks are *Carboniferous Limestone*, capped by *Coal Measures*; while east of that valley there are Carboniferous Limestones and Shales overlying a tract of *Silurian rocks* (Lower Old Red Sandstone). The arenaceous Carboniferous rocks to the eastward were mapped by Griffith as *Calp*, but of late years they have been said to belong to the *Lower Coal Measures*. No good proofs, however, in favour of this change of classification seem to be forthcoming, while they are very similar to the Calp rocks north of the TYRONE COAL-FIELD.

At Lisbellaw, S.E. of Upper Lough Erne, is a small exposure of *Ordovicians*; while to the north and north-east of the same lake are portions of the adjoining tracts of *Metamorphic rocks*, which may be either *Cambrians* or *Ordovicians*.

Except in connexion with the clay-iron-stone in the *Coal Measures*, this county is absent from Griffith's list; but since that was published, copper, iron, and molybdenite have been found at Castle Caldwell in the *Metamorphic rocks*. No mineral lodes have been found in the Carboniferous limestones or in the *Silurians*; this, however, may be due to the great head of drift, or bog, over those areas.

During the years 1620 to 1641 extensive mining and milling of iron was in progress, the principal works belonging to Sir J. Dunbar and Sir L. Bleverhasset (Blennerhasset). In latter years also the iron appears to have been mined and smelted until the forests were exhausted.

GALWAY.

Except the north-western portion of the county (Yar or West Connaught), the rocks are principally *Carboniferous Limestones*, with subordinate sandstones and shales; but through these come up detached exposures of *Ordovicians*. Yar Connaught is occupied nearly altogether by metamorphosed *Ordovicians* and *Cambrians*, with their associated *Granites* and *Granitic rocks*; but on them, to the north, is a tract of *Silurians*.

As it has been stated that some of the Yar Connaught rocks are Laurentians, it may be pointed out that when Murchison some years ago suggested that the oldest rocks of the county, those of the Bennabeola Hills, were of that age, he afterwards found reasons to withdraw his suggestion; while the rocks now stated to be of that age carry fossils of Llandeilo types.

In the Carboniferous Limestones some good and rich silver-lead accumulations have been worked; but unfortunately, as at Caherglassan, near Gort, and elsewhere, on account of the cavernous nature of the rock, and the low altitude of the county, they cannot be profitably worked, the influx of water being too great. Some of the lead mines in the south-east of the county are supposed to be prehistoric, not having been worked since 1640, and probably not for centuries previous.

In the Metamorphic and Granitic rocks are many lodes and indications of copper, sulphur ores, lead, and zinc; some very rich bunches having been already extracted. All the mining operations in the area have been on a small scale, proving the lodes at the surface, but not in depth; and from what is now known it would appear as if at some future time it might be the seat of large and remunerative mining operations, more especially if reducing works were erected in the county, as, on account of the great preponderance of sulphur ores (*pyrite* and *pyrrhotite*), the ores in their raw state will not bear the expense of long carriage.

At intervals between 1620 to 1750 iron was extensively smelted and milled in different places along Lough Derg, the last furnace alight being that of Woodford, belonging to the Burkes of Marble Hill. In these furnaces the bog-iron-ore was

in part used ; but it was mixed with clay-iron-stone from counties Limerick and Clare, and limonite from Tomgraney, Co. Clare, brought up the Shannon in boats ; the furnace and mills being erected hereabouts, on account of the vast forests in the neighbouring hills.

There were also furnaces in places on the western coast : to these foreign ore was brought by sea, to be mixed with the native bog-iron-ore.

The native sulphur found in the limestone at Oughterard seems to be long known, as the ancient name of the river is Owenriff, *anglice* Brimstone River. Blue fluor spar occurs at Inverin, west of Spiddal, while pale-bluish, greenish, and yellowish translucent varieties were found at Glengowla, near Oughterard.

KERRY.

In the south-west of the county, including the promontory of Ieveragh and the Killarney hills, are *Devonians* and *Silurians* similar to those of West Cork (see page 77), having on them, alongside the bay called Kenmare River, *Yellow Sandstone* and *Carboniferous Slate* ; but eastward, at Kenmare, these are replaced by cleaved *Limestone* and *Lower Limestone Shale*, or the transition rocks between those of the West Cork types and those of the Central plain types (*West Cork rock*, p. 77).

In the Dingle promontory there are *Silurians* and *Ordovicians*. To the northward and eastward (Slieve Mish) these are capped unconformably by rocks that represent the upper portions of the *Devonian* rocks of West Cork ; while further northward in the Kerry Head promontory are similar rocks. The Kerry Head and Slieve Mish *Devonians* lie conformable under the *Carboniferous Sandstone Shales* and *Limestones* of the low country to the eastward, the latter being capped by *Coal Measures*, a part of the extensive WEST MUNSTER COAL-FIELD.

As has been mentioned, in the *resumé* on Cork, the coals known in the Kerry portion of this field are of little value, while there are small prospects of better being found. In general these are more or less culm, or thin. Not much clay-iron-stone is recorded ; some, however, was raised in old times.

In the Carboniferous Limestone silver-lead and silver occur in various places ; but, except in the Killarney district, the lodes or strings in general have not been very large. The Killarney lodes have been long known, having been worked in the eleventh century. Nemius, writing at the time, states: copper, lead, tin, and iron were found there. Smith, in his history, also says he found some tin-ore ; but in subsequent time it has been unknown, and never was worked.

When working the copper mine at Muckcross, in 1794, M. Raspe discovered cobalt, bloom and grey cobalt. After the discovery little remained to be utilized, as all the accumulation, except about twenty tons, had been run into the lake as rubbish. The small portion saved had been surreptitiously carried away by a miner who recognized it as Erythrite (*Kane*).

Near Castleisland there is a slate, called *Lapis Hibernicus*, which was formerly worked and carted to Tralee, to be used in the manufacture of copperas. This industry had, however, to be abandoned, on account of the difficulty and expense of the carriage of the copperas to the nearest market.

In the seventeenth century, on account of the extensive forests, various iron furnaces were erected in places along the coast, to which iron-ore was imported. The Earl of Cork, however, seems to have smelted native ore near the south of the country, while there are also the ruins of furnaces and works at Killarney.

Lewis records copper pyrites as having been found prior to 1837 in Glancrough.

A vein of amethyst of a very beautiful colour, near Kerry Head, was formerly used for jewellery.

KILDARE.

This county is situated near the eastern margin of the great central area of *Carboniferous Limestones*, which, to the eastward, except south of Celbridge, seem to lie direct on the *Ordovicians*. South of Celbridge to the east of Ballitore, and in connexion with the Chair of Kildare range of hills are small tracts of *Lower Carboniferous Sandstone*, with an exposure of *Ordovicians* in the last. At the eastern margin of the county, intruding into the *Ordovicians*, there is *Granite*.

The county in general is covered by drift, or bog, and only in a few places have mineral veins been discovered. Lead was mined at Wheatfield, near Celbridge, in 1828; while Lewis records copper and iron as having been found in the Ordovician rocks of Dunmurry, near Kildare, in 1786.

No gold is now found in the county; yet tradition has it, that ancient Placers were worked somewhere near Ballymore-Eustace. At one time the Upper Liffey, above Poulaphuca, must have run northward along the flats at the meeting of Wicklow and Kildare to join into the Slaney at Baltinglass; and it is possible that somewhere in these ancient river-gravels the traditional Placers were situated.

In the counties Dublin, Wicklow, and Wexford, to the eastward of the Leinster Granite range, in the Metamorphic Ordovicians, are mineral veins; while, as pointed out by previous writers, none have been found in the similar rocks westward of the Granite, except the iron vein in Glenasplinkeen, Co. Wicklow. This possibly may be due to the deep limestone gravel, extending from the plain up on to the Granite, often to the height of 400 feet, and in places to 500 feet or more, thus preventing the Metamorphic rocks being properly seen or examined; as eastward of the range, where the mineral veins have been found, these drifts rarely occur above the 250 feet contour line. Similarly in the Co. Wexford, to the eastward of the range, where the rocks are more blinded by this drift, the mineral localities known, are fewer than in the Co. Wicklow.

KILKENNY.

To the south-east of the county there is an area of *Ordovicians*, having in it intrudes of *Granite*; while to the west, and extending into the Co. Tipperary, is a small exposure of *Ordovicians*. Margining the Ordovicians is *Lower Carboniferous Sandstone*, and on it *Carboniferous Limestone*; while to the northward, surmounting all, are *Coal Measures*, a part of the LEINSTER COAL-FIELD.

As the anthracite was first worked in Kilkenny by the English, the general name of "Kilkenny coal" has been given to this Irish coal; we may therefore here give a *resumé* of the history of the field.

In old times iron-ore was raised and wrought in the *LINSTER COAL-FIELD*, but when, and by whom, does not appear to be now known, the first authentic records being those of the English, between 1615 and 1641. At this time Christopher Wandesford had extensive mines and works, principally in Idrone, Co. Carlow, where, besides other things, he cast and wrought ordnance. Sir Charles Coote had large workings in the Queen's Co., his furnaces and mills being at Mountrath; while in the same county Lord Londonderry had a furnace and mills at Ballynakill, and Sergeant Pigott at Dysert.¹ All these appear to have been burnt down in 1641, but were afterwards rebuilt, and the manufacture was carried on as long as the forest lasted. It is said that after 1728 attempts had been made to smelt the iron-ore with the anthracite, but none of them were successful.

According to Boate, coal was first discovered near Wandesford's furnace in Idrone, Co. Carlow, between 1630 and '40, while the miners were raising the clay-iron-stone. He states that the county people worked it along the edge, or basset, for their own use, but suggests that when the forests were exhausted it might come in handy. But the first pit opened was not till 1728, either in Carlow or the adjoining portion of Kilkenny. Here the coal was found to be bad, and other pits were sunk in Coolbaun Hill, near Castlecomer, where three seams were found and successfully worked. Besides these three coals, which are only found in Coolbaun Hill, others that have been found profitable to work are the *Old Colliery Three-foot Coal*, the *Rushes* or *Modubeagh Coal*, and a curious channel called the *Jarrow Coal*, which occurs in connexion with the *Old One-foot Coal*.

The *Old Colliery Three-foot* is practically worked out; what little that remains would scarcely pay for the getting. The *One-foot Coal*, which is often only five or six inches high, does not pay for working; but the *Jarrow Channel*, in connexion with it, has been very profitable. Unfortunately it was only of limited extent, occurring in a semicircle to the north of Coolbaun Hill, and in a nearly straight line to the south of it. Of this coal there now remains about a mile and a-half in length to the north of Coolbaun, and about two miles to the south. According to

¹ See Dysert, King's Co., p. 90.

Mr. Dobbs' estimate it is profitable for a width of 400 yards, and is of an average height of three feet. If every cubic yard is equal to a ton of coal, we have in these portions of the channel about 2,500,000 tons of unwrought coal. There are outlying portions of this channel still unworked, which may contain something between 250,000 and 500,000 tons of coal. If the highest figure is taken, which is probably above the estimate, there will be less than 3,000,000 of tons of unwrought coal.

The only other coal available is the Modubeagh Coal. This, under the name of Towlerton Coal, Mr. Hull estimates as profitable, about 10,000,000 tons. This estimate, however, is evidently excessive, the coal being taken as two feet high, while it rarely exceeds one foot nine inches, and in places has thinned to nearly half that height. A foot coal would be valueless, as, on account of its great depth from the surface (about 216 yards below the Old Three-foot Coal), the cost of "getting" would exceed the value of the coal. Whether it is of any value cannot be known until a bore-hole is put down somewhere near the centre of the colliery. At no time was there much profitable coal in the field. It began to be mined about a century and a-half ago (1728), and now it is nearly exhausted.

The anthracite is of four classes—*stone coal*; *kennel*, or hard compact shaly coal; *culm*, or friable flaky coal; and *kelce*, or shaly earthy, impure coal.

Very few mineral veins have been found in the county. In the valley of the Nore was the silver mine called Argetros, which, according to the Annals, was worked A. M. 3817. In this valley silver and lead have been found at Ballygallon, near Inistioge, and Knockadrian, near Knocktopher: at the latter place, recently, they were worked for some years successfully.

KING'S COUNTY.

The majority of the rocks within the limits of this very irregular county belong to the *Carboniferous Limestone*. In these are a few exposures of *Sandstone*, and to the north of Phillipstown an intrude of *Whinstone*. At the south-east is a portion of Slieve Bloom, wherein is found an exposure of *Ordovician*s flanked by *Carboniferous Sandstones*.

As the county is for the most part enveloped in drift or bog, only a few mineral veins have been found, although it is possible more may exist, chalybeate springs being so numerous; some of the latter, however, are evidently due to the decomposition of the pyrites in the $\frac{1}{2}$ Calp. A lead mine was for a time worked at Edenderry.

Boate mentions that prior to 1640, Sergeant-Major Pigott mined and smelted iron ore (*limonite*?) at "Dysert lands" in "the King's County," and from his account the mining works must have been extensive. At the same time Sir Adam Loftus, Viscount of Ely, had works near Mountmellick, but where he procured the ore is not stated.

The mearings of the King's and Queen's counties have been changed at different times, and portions that were in the King's County in Boate's time may now be in the Queen's: the place, Dysert Land, has not been localized, and possibly it may be the iron mines at Desert in the Queen's County (Sheets 13 and 18), now the property of Lord Carew.

LEITRIM.

Nearly the whole of Leitrim is occupied by *Carboniferous* rocks, including a portion of the CONNAUGHT COAL-FIELD. At Manorhamilton, coming in from the Co. Sligo, is a narrow exposure of Metamorphic rocks, probably of *Cambrian* age, but possibly older. At the south-east of the county is the marginal portion of a tract of *Ordovicians*; while a little exposure of similar rocks, surrounded by *Carboniferous Sandstone*, appears to the south-east, close to the Shannon.

The coals and the working of iron in the CONNAUGHT COAL-FIELD is given in the description of the Co. Cavan, page 71. Besides the clay-iron-stone of the Coal Measures and the bog-iron-ore limonite was also mined and smelted in the seventeenth and eighteenth centuries procured from the *Ordovicians* at Gortinee, south-east of Drumsna near the Shannon. In late years, between 1860 and 1880, some ore was also raised here, and exported to England.

In the Metamorphic Cambrians (?) at Gortnaskeagh, Pollboy,

and Shanvans, N. W. of Manorhamilton, copper was mined prior to 1845, while lead was raised in the adjoining mine of Twigspark. The lodes at Pollboy and Shanvans, although in the Metamorphic rocks appear to have been of Carboniferous or of post-Carboniferous age; as associated with the ores, "copper with a little lead," there was Dolomite. From the position of the lodes it may be suggested that they are "contact lodes," at the junction of the Carboniferous and the Metamorphic rocks, they belonging to the same class of lodes as the great lode at Silvermines, Co. Tipperary. Along the line of contact there ought to be other deposits not yet discovered.

The old attals and shafts prove early mining operations; but the date at which the lode was first worked seems to be now unknown.

LIMERICK.

To the south-east, coming in from the Co. Tipperary (a part of Slieve Phelim) are *Ordovician* rocks, capped by *Carboniferous Sandstones* (Upper Old Red); while the rest of the area is occupied by limestone or other *Carboniferous* rocks. To the west there are *Coal Measures*, a part of the WEST MUNSTER COAL-FIELD; while between these hills and those of Slieve Phelim the plain is principally occupied by the *Carboniferous Limestone*, but having associated with it beds and intrudes of *Volcanic* rocks and a few outlying *Sandstone* exposures.

At Ballybrood there is a small patch of *Coal Measure* surrounded by *Volcanic* rocks; the latter possibly represent the ruined walls of a Carboniferous Volcano.

As has been mentioned in the description of the Co. Cork, the coals in the Co. Limerick are thin: formerly they were worked at or near their outcrop; but no deep trials has been satisfactory, the coals proved, not to be sufficient in quantity or quality to pay for deep workings. Iron ore, in the seventeenth and early part of the eighteenth centuries seems to have been extensively worked, especially in the vicinity of the Shannon; partly to supply the furnaces near Glin and Loughill, and in part to be sent by boat up the Shannon for the use of the furnaces and mills in the vicinity of Lough Derg.

In the Co. Limerick, more than elsewhere in Ireland, the

Carboniferous Limestone is divided into Lower Shaly Limestone Fenestella Limestone, and Calp; the latter in part of the Burren type. Above and below the Fenestella Limestone are well-marked cherty zones, and below both of these, especially the first, mineral accumulations occur. Some rich pockets and shoots were found and worked out prior to 1850; while since then lead has been found in a few places, but the extent of the deposits have not been proved. According to Lewis (1837), "there are indications of a valuable mineral ore near Tory Hill;" no trials, however, seem to have been made thereabouts.

In the Carboniferous Sandstone and the Ordovicians a few small veins with copper have been found, but not sufficient to make mines.

Large amethysts and cairngorms are found near Shanid Castle and Foynes.

LONDONDERRY.

At the east of the county, extending in from the Co. Antrim, there is a tract of *Eocene* (?) *Doleryte*, which overlies the *Cretaceous*, *Jurassic*, *Triassic*, and *Carboniferous* rocks. To the northward the rocks of these older formations, except the Carboniferous, form more or less narrow, continuous, successive strips, margining the Doleryte; but southward the latter more or less overlaps them all. The Carboniferous rocks are for the most part of the North of Ireland "Calp type;" but in places there are good limestones, and in others sandstones and conglomerates of the *Lower Carboniferous types*. The Carboniferous rocks were evidently accumulated in valleys in the older Metamorphic rocks, which occupy the rest of the area, and therefrom into the counties of Donegal and Tyrone. They are probably of Ordovician age. With the Metamorphic rocks are associated intrudes of Granite.

In the Eocene (?) *Diorytes*, as in the Co. Antrim, there are beds of iron-ore; but not as numerous or valuable. In the Calp shales near Draperstown are clay-iron-stone bands and nodules: worked by Rennie, and smelted in the valley of the Moyola, prior to 1640. This Iron Master also mined hematite and limonite in the Ordovician and Granite rocks. Between 1860 and 1870 openings were made on these lodes, but no permanent work done,

on account of the depression in the iron trade. In the Ordovician rocks the iron in general, is associated with manganese.

Traces of copper and sulphur ores have been found in the rocks (*Ordovicians*) of the Ballinascreen mountains, but none of the veins have been opened up.

Prior to 1641 Boate records gold as occurring in the gravels of the Moyola river, but since then none seems to have been found.

There is a possibility that Coal Measures, with profitable coals may yet be found under the Trias at the south-east of the county.— See *Ulster Coal-field*, Co. Tyrone, p. 298.

Portlock calls attention to large beds of ochre at Aughlish and Tamnagh, in the parish of Banagher, and Glenviggan in the parish of Ballinascreen, as suitable for making red paint, similar to that employed in Sweden to paint and preserve the wooden houses. The surface deposits, or bog-iron-ore, is in places at present exported, to be used in the purification of gas.

LONGFORD.

In the north-east of the county, coming in from the Co. Cavan, is the margin of a tract of *Ordovician* rocks. The rest of the area is principally *Carboniferous Limestones*, with, to the north, a margin of *Carboniferous Sandstones* and *Shales*. In a few places are small protrudes of *Ordovicians*, associated with *Carboniferous Sandstones*.

The localities for minerals are few (*see Lists*); the most important are the iron lodes at Cleenragh and Enaghan, near Lough Gowna. These were worked in the seventeenth century, and also prior to 1870, by Dr. Ritchie of Belfast. In the earlier times they seem to have been smelted in the county, but Ritchie exported them, carrying them across the lake in boats, and thence by rail to the port. Silver-lead is recorded as occurring in the *Carboniferous Limestones* at Longford.

LOUTH.

The major portion of this area is occupied by *Ordovician* rocks, on which, to the south, west, north, and north-east, are small tracts of *Carboniferous Limestones*, with its *Sandstones* and *Shales*.

To the north-east, forming a hilly country south-west of Carlingford Lough, are peculiar *Granitic and other Intrusive rocks*.

In different places in the Ordovicians, veins of lead and copper have been found, and at Jonesborough antimony; while mines were worked about the year 1840 at Salterstown, and near Clogher. At the junctions of the Granite and the Ordovicians traces of lead occur in different places.

Near Clogher Head there is a poor iron-ore, and in different places in the hills are the ruins of old iron works: the ore for the latter may have been imported.

MAYO.

In this county about half the area is occupied by Metamorphic rocks (probably *Ordovicians* and *Cambrians*) and their associated *Granites*. Some of the Metamorphic rocks are said to be *Laurentians*, but lithologically, and apparently petrologically, the younger rocks of the series are similar to the Co. Galway rocks that carry fossils of *Llandeilo* types. On them, to the south-west, and extending into the Co. Galway, are *Silurians*; while smaller tracts of the same age occur south, west, north, and north-east of Clew Bay, the last in Croagh Moyle, being the largest. The rest of the area is occupied by Carboniferous rocks. *Coal Measures*, &c.

A valueless coal occurs in the Coal Measure, but associated, with it is clay-iron-stone, that was worked to be smelted in Gildeas' furnace at Port Royal.

Limonite, or hematite, was mined in Cross and Tallaghan, barony of Erris, and in the Cloonaghan and Deel river valleys, barony of Tirawley. Formerly Sir George Shaen smelted and milled iron near the Mullet; while a little later Rutledge had works on the Deel. Both these Iron Masters had to discontinue their works for want of fuel when the woods were exhausted.

At Port Royal, near Ballinrobe, the Gildeas, in Charles II.'s time, were given a grant of land, in which they mined and smelted iron. The ore principally used was bog-iron-ore, mixed with the clay-iron-stone raised near Balla, some miles to the north; while tradition has it that they also procured limonite

from the neighbouring Silurian and Ordovician hills. The furnace at Port Royal is supposed to have been put out at the end of the eighteenth century, being one of the last wood charcoal furnaces alight.

Very few other mineral veins are recorded, those named being ores of copper, sulphur, and lead. A silver-lead mine was formerly worked at Sheefry, between Westport and Killary Bay; while trials were made on coppery lodes in Corraun Achill. On account of the great area of the county, and the favourable nature of the rocks, in places, it would appear possible, if proper search was made, that some profitable lodes might be found. Lewis states "rich deposits of manganese have been found in the neighbourhood of Westport."

MEATH.

To the south-east of this county, near Balbriggan, also north of the valley of the Boyne, there are tracts of *Ordovicians*; while the rest of the area is nearly solely occupied by *Carboniferous Limestones*, principally of the "Calp type." On it, in places, are small patches of *Coal Measure Shales*; while to the north, coming in from the county Monaghan, is the south end of a small tract of *Trias*, associated with a patch of *Coal Measures*.

In the *Trias* there is gypsum, formerly mined (*Monaghan*, page 56); and in the adjoining *Coal Measures* there is a thin coal, that was worked a little, along its outcrop. Although profitable copper lodes are not usually found in the Irish *Carboniferous Limestone*, yet about 1800 copper-ore was raised at three places near Walterstown; and subsequently at Beaupark, near Slane. Also in the *Carboniferous Limestone*, lead was worked at Athboy; while in the *Ordovicians* at Ologher, near Ardcath, there is a lead mine, considered by Griffith to be very ancient. Lewis reports a "rich copper lode," near the banks of the Boyne, "unworkable profitably on account of the influx of water."

MONAGHAN.

Both to the north and south are tracts of *Carboniferous* rocks; while on the latter is a small outlyer of *Trias*, margined eastward by *Coal Measures*. Nearly all the rest of the area is occupied by *Ordovicians*.

In the *Trias* to the S.W. of Carrickmacross there is a considerable deposit of gypsum, some time since mined and manufactured into "Plaster of Paris" at Knocknacran, until the works were burned down about the year 1869. In the *Coal Measure* is a valueless coal, while other valueless coals occur to the north of the county, near Slievebeagh. The tumblers of limonite found S.E. of Kingscourt are mentioned in the "Iron List," Part I.

Veins of lead-ore have been found in numerous places, those at Lisglassan and Tullybuck being associated with antimony; while in other places there was barytes, or a little zinc. Lewis states that in the "Creina Hills" there had been works for reducing lead; but they were abandoned some years prior to 1838.

The majority of the mines recorded in this county seem to have been worked between 1830 and 1855, but some before these dates. The lodes in this county appear in general to have been small; but, on account of their number, also that others occur in the neighbouring counties of Cavan, Armagh, and Louth, it would appear that mining might be remunerative when trade revives; especially if reducing works, calculated to utilize all the mineral products were erected at a good centre.

QUEEN'S COUNTY.

Slieve Bloom, which lies to the north-west of the county, has a nucleus of *Ordovicians*, the slopes of these hills being *Carboniferous Sandstones and Shales*. The rest of the area is occupied by *Carboniferous Limestones* and *Coal Measures*, the latter being a portion of the LEINSTER COAL-FIELD.

The iron ore and coals have already been described with those of the Co. Kilkenny (page 87). In this county coal was first

discovered at Gale and Cullenagh Hills while working the iron-ores. The "Gale Hill coal" is interesting, as one of the first discovered; but is also important because a little below it, is the great horizon where the iron-ore was worked in the seventeenth century. For no apparent reason, except it may be to introduce a new set of names for the coals, this coal has been ignored in the second "Geological Survey Memoir," published in 1881 (*Parts of sheets, 127, 128, 136, 137, &c., by Messrs. Hull and Hardman*); although the same coal, under a new name, is recognized in other places. After Wandersford, in 1728, commenced to mine in the Co. Kilkenny, the Grand Canal Company and others put down a number of bore-holes in this county, thereby proving the extension of the Kilkenny coals. These coals, however, are now nearly worked out (page 89).

The iron mining, smelting, and working (*List of Iron Masters*, page 63) were considerable, both before and after 1641, and only ceased when the forests were exhausted. At Dysert, near Maryborough, the property of Lord Carew, are limonite veins, formerly extensively worked; there, as previously suggested (page 90), may be the mines mentioned by Boate as situated in the King's Co., and worked by Sergeant Pigott.

Traces of copper and lead have been found in the Ordovicians of Slieve Bloom, but the localities are not recorded.

ROSCOMMON.

In the Curlew Mountains, at the north of the county, are reddish and greenish *Silurians*, with their associated felspathic Exotic rocks, the Silurians being margined by *Lower Carboniferous Sandstones and Shales*. To the east, near the Shannon, in Slieve Baun, are small exposures of *Ordovicians*, also margined by similar rocks; while the latter also form small tracts to the W.S.W. of Roscommon, and the N.E. of Castlereagh. Most of the rest of the area is occupied by *Carboniferous Limestones*, they having on them at Lough Allen—*Coal Measures*—a portion of the CONNAUGHT COAL-FIELD.

The coals and clay-iron-stone appear in the description of the Co. Cavan (page 71). No other metallic ores are recorded. In

places, however, there appear to be indications of lodes, but the great head of drift, or bog, prevents them from being easily found.

SLIGO.

The *Carboniferous Limestones* occupy the principal portion of this area, having on them to the south-east a small but rich tract of *Coal Measures*, part of the CONNAUGHT COAL-FIELD. Crossing the county obliquely is the Ox Mountain range, the rocks being metamorphic, flanked in places by *Lower Carboniferous Sandstone*: these Metamorphic rocks are probably of *Cambrian* and *Ordovician* ages, although, from their lithological characters solely, they are stated by Professor Hull to be *Laurentians*; but the petrological evidence seems to be conclusive against such an age. At the south margin of the county are small exposures of the Curlew Mountain *Silurians*.

The coals and clay-iron-stone of the CONNAUGHT COAL-FIELD are mentioned in the history of the Co. Cavan. Other iron-ores, however, seem to have been raised, and were smelted at Ballintogher "and at the base of the Ox Mountains." Lewis also states, when writing in 1837, that "near Screevenamuck are excavations, where the ore was raised as long as timber could be procured for smelting it, the last furnace having been put out in 1768." At Ballynakill, between Ballintogher and Rivers-town, are the ruins of extensive iron works; while limonite appears to have been mined in the adjoining Carboniferous Limestone.

Lead has been worked in the Metamorphic rocks, and silver-lead in the Carboniferous Limestones near Ballysodare; while lead, copper, and barytes have been found and worked in the King's Mountain. The Abbeytown mine, near Ballysodare, has been worked on and off during the last hundred years. In Glencarberry, King's Mountain, unsuccessful attempts to work profitably the large accumulation of barytes were made between 1870 and 1880.

Well-coloured and well-shaped large amethysts have been procured in the neighbourhood of Ballymote.

TIPPERARY.

The Killenaule, or EAST MUNSTER COAL-FIELD, lies to the east of this county, it being joined to the Kilkenny field by a tract of *Lower Coal Measures*—while outlying small patches of the latter are found N. E. and S. W. of Fethard, N. W. of Clonmel, at the Rock of Cashel, and in Slievenamuck, S. W. of Tipperary. To the S. E. of the area in Slievenaman are *Ordovicians*, flanked by *Lower Carboniferous Sandstone*; to the S. W., in Knockmealdon, are rocks that possibly may be the eastern extension of the Co. Cork, *Devonian* and *Silurians*; to the west, in the Galtees and Slievenamuck, are small exposures of *Ordovicians*, margined by *Lower Carboniferous Sandstone*; and to the N. W., in the Arra Mountains, and Slieve Phelim, are similar groups of rocks, similarly related; while most of the low country is occupied by the *Carboniferous Limestones*.

Between 1730 and 1740, coal was searched for and found by the Langleys in the Coalbrook Colliery, but some forty or fifty years seem to have elapsed before it was worked by the Goings in Earl's Hill; and elsewhere by the Mining Company of Ireland—the collieries not being well developed till after 1825.

The profitable coals were—*Surface, Parkenaclea, Clashacona, Main, and Glengoola*. All the beds above the Main coal were solely found in Earl's Hill, where the measures are thickest, while the Main coal, besides here, was only found in some detached basins. All the profitable portions of these coals, except the Glengoola beds, and small tracts of limited extent of others, seem now to be worked out.

Associated with the Glengoola coal in Coalbrook and elsewhere are some seams of rich clay-iron-stone, but I can find no records of these having been mined or smelted. Other iron ore, however, was raised in the older rocks, and smelted at Gortnahalla, in the valley of the Clodiagh, to the S. W. of Borrisoleagh. Some ore is also said to have been raised and smelted near Roscrea: these latter works may, however, have been in the King's County.

At Gleninchinaveigh, near Upper Cross, there is a vein containing anthracite and graphite, four feet wide at surface. This, in 1857, was sunk on for a depth of ten fathoms, but the walls

closed in and cut it out; it was also driven on for five or six fathoms.

Lead, copper, and other minerals, as given in the Lists, Part I., have been found and worked in different places; there having been prehistoric workings on the silver-lead at Garrane, near Toomavara; at Silvermines, near Nenagh; and at Garrykennedy, on Lough Derg.

Of the mines, the most important and interesting are those on the great Mineral Channel at Silvermines. Boate states, in rather disparaging terms, that this mine was first discovered by the English about the year 1600; but the researches made during the present century, and the statements in the Annals, would suggest it had previously been worked by the ancient Irish, as were also the mines to the westward, at Garrykennedy; and to the eastward, at Garrane.

From Boate we learn that at first, Silvermine was supposed to be a lead mine, but afterwards they found it contained "three pounds of silver to the ton of lead;" also "some quicksilver." As far as I can learn no trace of the latter has been detected in late years. Under the King the mine was farmed by Sir William Russel, Sir Basil Brook, and Sir George Hamilton; but the mine was destroyed, and the works burnt down in 1641, by Hugh O'Kennedy, brother to John Mac Dermott O'Kennedy, who ought to have been its legitimate owner. After the troubled times the English company seem to have again worked it till their lease expired, about 1730: subsequent to this it was worked by different companies, who found and opened up new lodes, till eventually it came into the hands of a Mr. Hudson, who at the beginning of the present century sold his interest to the General Mining Company of Ireland; these carried on active operations till about 1870.

After the time of the English company various lodes were discovered in the county to the westward; some of them containing argentiferous copper and lead, others argentiferous lead—the latter giving eighty ounces of silver to the ton. In 1858, Captain Thomas King, while exploring the ancient lead and silver mines, discovered electric calimine; it evidently being due to the chemical decomposition of the blende that had been run as attals or wastes into the ancient levels; this for some time was profitably worked.

The Silvermines Mineral Channel is interesting, being a "con-

tact lode" at the junction of the Carboniferous and Ordovician rocks, extending for at least thirty miles; from Gallow's Hill, Co. Clare, to the westward; to Toomavara on the eastward. Along this line mines have been worked at Garran, near Toomavara, and at Silvermines; while indications have been detected in the Co. Clare, which seem to suggest that in other places along this "contact break" profitable lodes may yet be discovered.

At Lackamore, copper was raised in old times, while an unsuccessful attempt to work the lodes was made between 1800 and 1810; they were subsequently opened on by the Mining Company, who broke some very rich ore; but as the quantity was small, they also abandoned them. The last adventurers were the Messrs. Taylors of London, who raised some ore up to 1859. Lewis mentions a lode found in the townlands of Cappaghwhite, Ballysinode, and Gortdrum, which contains rich copper in bunches, and was leased to the Mining Company, who, in 1826, spent some money at Gortdrum, but apparently without any return.

At Hollyford there are two parallel lodes cut off by a cross-course. On the eastern, or Ballycolein lode, there was an ancient mine; as about 1850, at the cross course, were found "Old Mens" workings and tools. In 1858 the western lode was worked under Captain John Pascoe, while subsequently the mines got into the hands of an English bogus company, who became bankrupts.

TYRONE.

The geology of Tyrone is very interesting. To the north, coming in from Londonderry and Donegal, are Metamorphic rocks, which belong to two distinct geological periods, probably *Ordovicians* and *Cambrians*—south of the latter, at Pomeroy, are unaltered *Ordovicians*. Dr. Hicks has suggested that the older rocks may be Laurentians, but solely on account of their lithological characters; they are evidently of the same age as the older rocks in Donegal. The Pomeroy *Ordovicians* are overlaid by *Silurians* of the Fermanagh type, and those to the south and east by *Carboniferous Sandstones, Shales, and Limestones*; and on the latter, to the north-eastward of Dungannon, are the *Coal Measures of the ULSTER COAL-FIELDS*. Margining, and on the Coal Measure,

are *Trias rocks*; and in places *Cretaceous rocks* (White Limestone), *Eocene* (?) Doleryte, and the "Lough Neagh beds"—the age of the last being still disputed.

Associated with the Metamorphic rocks are *Granitic rocks* of three or more distinct ages. In the westward and north-westward there are other tracts of Carboniferous rocks.

In the south of the county the Carboniferous rocks have well marked divisions, having a central zone of sandstones and shales (*Calp*), while to the westward and north-westward they are more mixed up. The Calp of Ulster is more or less similar to the Coal Measure sandstones and shales, having in it, in the Co. Derry, workable beds of clay-iron-stone; and at Ballycastle, Co. Antrim, workable coals. By some observers the rocks of these two distinct groups have been confounded together. This is a matter of importance, as this incorrect mapping has led persons to make unsuccessful trials for coal in the Calp.

In the Silurian are the characteristic felspathic bedded rocks (*eurytes*); while associated with the Trias, in the north of the county, are dolomytes, said to contain fossils of *Permian types*.

In the "Lough Neagh beds" are seams of lignite, but too insignificant to be valuable; silicious pieces of the lignite are known as "Lough Neagh hones."

In the Trias at Croagh, also elsewhere, gypsum has been found, but not in sufficient quantity to be economically worked.

The Tyrone coals are seemingly of great importance. As has already been mentioned, the coals in Leinster and Munster are in the *Upper Measures*, and those in the Connaught field in the *Middle Measures*; but in Tyrone they are found both in the *Middle and Upper Measures*. Furthermore, the Ulster are gas coals, while those of Leinster and Munster are anthracites; those of the Connaught field seem to be intermediate between both. The extent of the coal-field is unknown; for although the coal at the margins of the exposed field must extend under the adjoining younger rocks, this extension has never been proved by either borings or sinkings.

The coals at Drumglass, near Dungannon, in the *Middle Measures*, have had their exact height above the Limestone proved by a series of bore-holes; but their extent is unknown, as it is still an open question whether they extend under the whole or only a part of the field.

The coals of the *Upper Measures* in Annagher, Coalisland, and Annaghone have respectively individual characteristics. It has been supposed that those of the Annagher series are above the Coalisland series, but there are no positive proofs that this is the case, while the facts appear to be against such a supposition. The *Baltiboy* coal of the Coalisland series is said to be the sixth or lowest coal of the Annagher series. This, according to the published section, is, at the most, only 192 feet above the *Derry* or highest workable coal in the Coalisland series; while in the intervening measures there are four thin coals, ranging from nine inches to two feet in thickness; but in the bore-hole put down by Griffith for a depth of 270 feet below the sixth coal at Annagher no coal was found. It is possible that these four minor coals might have died out, and be unrepresented in the measures under Annagher; but it is scarcely possible that the *Derry Coal*, from three to five feet thick, should be totally absent. In the Annaghone Colliery, the *Main Coal* is said to be "undoubtedly" the Annagher *Nine-foot Coal*, which would necessitate a down throw to the eastward of over 2000 feet. It seems to me therefore more likely that the different series of coals in the several portions of the Upper Measures, are in more or less detached basins, in each of which the strata were accumulated under different conditions, similarly as in Kilkenny and Tipperary.

We, however, do know, that in the *Annagher series* there are four coals, over 2·5 feet thick, more or less capable of being profitably worked; while in the *Coalisland series* there are three coals, over three feet high. The *Annaghone* colliery had a coal nine feet thick, and above it another that varies from 1·5 to 3 feet. There are no apparent reasons why these Annaghone coals may not extend northward and north-eastward under the Trias, even into the Co. Londonderry.

From the very imperfect data at present procurable there is no possibility of making any sort of an approximate estimate of the quantity of unwrought profitable coal in this portion of Ulster; but it appears safe to suggest that there is probably much more unwrought coal here, than elsewhere in Ireland.

The coals are bituminous, and when burnt have a white ash; near the surface they are brittle, but improve in depth. They were not wrought, at least extensively, until the present century,

when they were systematically looked for by Griffith and the Hibernian Mining Company.

In places in the Coal Measures good clay-iron-stone is found ; but I cannot find any records of its having been raised or smelted in old or modern times. Elsewhere, however, in the Carboniferous Limestone and the Ordovicians, hematite and limonite were raised for smelting in the seventeenth and eighteenth centuries, and more recently for exportation (*see Londonderry, page 92*), the localities being given in the List, Part I.¹

Antimony has been found in the Munterlong Mountains, and lead in Crookanboy and Trebane West, all near Gortin ; but none of the minerals appear to have been worked. In the Silurians at Crannogue, near Pomeroy, a little copper was raised ; while elsewhere in these rocks, both in this county and also in Fermanagh, there are traces and indications of this mineral, which would suggest that, if properly searched for, a paying lode might be found.

WATERFORD.

In the west of the county of Waterford is the eastern termination of the rocks of the *Cork types*, they gradually, eastward and northward, changing into the ordinary *Central Ireland types*.

To the eastward, coming in from the Co. Wexford, are *Ordovicians*, with their associated, more or less interbedded, igneous rocks ; and over these, to the northward, are *Lower Carboniferous Sandstones, Shales, and Limestones*. But to the westward, in the Comeragh Mountains, on these Ordovicians are, more or less, conglomeritic and argillaceous rocks ; and these possibly are the representatives of the littoral accumulation of the Cork *Devonian* or even *Silurian* ; this, however, has still to be proved. To the S.E., at the Bonmahon mines are a few patches of similar conglomerates, which for the reason stated hereafter (*Wexford, p. 107*) are supposed to be *Silurians*. *Devonian* (or *Silurian*) seem also to occur further south, in the long hill, or "drum," between the two Decies.

¹ Clay-iron-stone is recorded by Boate as having being worked in the Calp (?) shales, in "Nether Tyrone, by the side of the rivulet Lishan." "Nether Tyrone" is the present Co. Londonderry.

On the Devonians(?), lying in nearly east and west troughs, are *Lower Carboniferous Sandstone, Shales, and Limestones*.

In the Devonian rocks of the Coshes and the Decies baronies, that is, south of the valley from Lismore to Dungarvan, iron ore was extensively raised for smelting in the seventeenth and eighteenth centuries; Lord Cork having large works at Saltersbridge, while Sir Walter Raleigh's principal mines were at Dromalig; but the ores from Minehead and Ardmore were specially prized, as they could be converted into the finest steel. Here, as elsewhere, the furnaces were probably in the vicinity of the mines. When Smith wrote in 1750, Lord Cork's furnace only appears to have been alight, and it was put out shortly afterwards. In Dromalig and the neighbouring townlands iron ore, for exportation, was raised between 1850 and 1860, and even a little later.

Very valuable lodes, both of lead and copper, were formerly worked in different places in the *Second, or Ballymoney Series* of the Ordovicians. Lewis mentions a valuable silver-lead lode that was worked at the Hill of Cruagh, parish of Riesk (*Sheet 17*); and another of lead in the River Mahon Valley, near Mountain Castle (*Sheet 15*); also silver-lead that was dug out of the sands of Kil-murrin beach. These three localities seem to have escaped Griffith's notice, as they do not appear to be mentioned by him. Nothing is now known of the copper and silver-lead lodes worked near Ardmore; but, from the specimens found in the waste heaps, they are supposed to have been rich.

In this county the best known mines are the "Bonmahon Coppers," so called as the major portion of the ore was copper, although in the setts some valuable silver-lead veins were also found and worked. At Knockmahon, mines were worked in the old days, as in the "Stage Lode" "Old Men's workings," with wooden and stone implements, were found. Subsequently, from Queen Elizabeth's time, down to 1730, some of the lodes, at intervals, appear to have been worked, while at the latter date they were in the hands of a Mr. Hume, who for some years worked the Stage Lode very successfully. Next we hear of Colonel Hall, and Mr. Galway, who spent a large sum unsuccessfully, and they, in 1796, passed their interests to the Hibernia Mining Company. These also do not seem to have been successful, as they sold the property, in 1824, to the Mining Company of Ireland. The latter

from that date, until about 1876, carried on the mining with varying success; while about 1880 the works were totally dismantled. The last adventurers seem to have been more extensive in their operations than any of their predecessors, as they held five royalties—Tankardstown, Knockmahon, Kilduane, Ballinasilla, and Bonmahon. Their first mine was on the “Trawna Stella” lode, in the west portion of Bonmahon; hence the name by which all the mines were afterwards known.

The future of these mines is very obscure, as from appearances there seems to be no hope for them; but it must be remembered that although adventurer after adventurer gave them up as valueless, yet the Mining Company found riches—the nett profits of the mines in 1862 alone exceeding £20,000. (*See Du Noyer, Ex. Sheet 168, Geol. Map, p. 81*).

WESTMEATH.

This area is occupied by *Carboniferous Limestones*, except a small exposure of *Lower Carboniferous Sandstone* near Moate, a second west of Kilbeggan, and a minute tract of *Ordovicians*, margined by *Carboniferous Lower Sandstone*, to the north of Killucan.

This county is absent from Griffith's lists, there being no recent mines in it. Small bits of lead and copper have been picked up in places; while coaly seams and clay-iron-stones have been found in the Calp shales. There is no prospect of profitable coal ever being found; but copper and lead veins, especially the last, ought to exist, but are hard to discover on account of the envelope of drift and bog.

In places there are the traces of old iron works, while it is possible that some of the Calp iron ores were utilized.

WEXFORD.

Two-thirds of this county are *Ordovicians*, in part metamorphosed. These are fringed along their N.W. margin by *Granite*, part of the great intrude of the Leinster range. S. E. of the *Ordovicians*, and coming up from under them, are *Cambrians*.

The latter are also, in part, metamorphosed; those at Carnsore, to the south-east, being changed into *Granitic rocks*. Patches of these rocks, for no apparent reason, except lithological characters, are said to be of *Laurentian* age. Crossing the Cambrian, and on the Ordovician, in Hook Promontory, are *Carboniferous Limestones, Shales, and Sandstones*.

To the south-east, on the Cambrians, adjoining Ballygeary Bay, is a small outlying tract of Ordovicians. Formerly on the coast, to the S. E. of the new pier, the basal bed, a fine conglomerate, identical in aspect with the silurian conglomerate at Bonmahon, Co. Waterford (page 104), could be seen, but now it is covered up by a sand accumulation.

The Ordovicians of S. E. Ireland are separated into three well-marked groups, which are traceable more or less distinctly in the rest of Ireland. These groups may be called, Lower—*Black Shale Series*; Middle—*Volcanic*, or *Ballymoney Series*; Upper—*Slate*, or *Slieve-Phelim Series*.

The known mineral veins are few, which may in part be due to the deep drift. A few veins of lead and copper, but not of much account, have been worked in the Ordovicians since the beginning of the century; while near Bannow Bay are attals, or old waste heaps, said to be the *debris* from mines worked by the Ostmen.

In this neighbourhood, at the Castles of Clonmines, there is said to have been a mint in the time of Charles II., the coins having been made from silver procured in the vicinity. Some lead and barytes are found in the Carboniferous rocks, and in one place concretions of native sulphur.

Prior to the stoppage of Chamney's iron works at Shillelagh, Co. Wicklow (Wicklow, p. 50), these Iron Masters smelted iron largely in bloomeries in the north-west portion of the county, and probably also raised ore, as traces of what seem to have been old workings have been observed near Galbally and elsewhere. There are also in different places, associated with the rocks of the *Ballymoney Series*, not only in this county, but also to the N. E., in the Co. Wicklow, and S. W. in the Co. Waterford "Black Heaps." These are of greater or less size, and consist of roasted shingle and black stuff, with, in some of them, what seems to have been a hearth. Some of the smaller ones are said to have been the places

where they "roasted the wild deer"¹ in former times; but others evidently appear to have been bloomeries, or for some such metallurgical process. The roasted shingle is principally broken-up fragments of the Ferriferous Felstones.

To the north of Gorey, at Ballynastraw, also elsewhere in the purple shales and slate of the lower portion of the *Slate Series*, are lentils, or irregularly-bedded masses of earthy limonite; while in places along the Ballymoney cliffs are beds, of a low percentage, of calybite. There are no records of these ores having been worked.

In the Ordovicians, anthracite, and in places plumbago, is recorded. At the north-east mearing of the county; in two places in the Ballymoney cliffs, where they have fire-clays and carbonaceous shales associated; at Greenfield, near Enniscorthy; near Wilton; in Doonoony; and near Castle Talbot; while it is reported to have been found in two places in the barony of Forth. From trials made the veins seem to be only from one to four inches wide, and of no value. Some of the best of the carbonaceous shales, if there were mines in the neighbourhood, might possibly be worked advantageously as a bye-product.

Some good specimens of asbestos are said to have been found at Bloomfield, near Enniscorthy.

WICKLOW.

To the north-east, adjoining the sea, are *Cambrians*; the rest of the county rocks are *Ordovicians*, associated with a wide intrude of *Granite*, part of the Leinster Granite range. There are also small detached outbursts of *Granite*, while the *Cambrians* and *Ordovicians* are in part metamorphosed.

The *Granites* belong to different Geological Periods. The main mass is Post-Ordovician, but with it, to the southward, in the parish of Shillelagh, and extending into Kildare and Carlow, is a considerable tract of a very coarsely crystalline rock, which might be called *Pegmatyte* (locally called *Bastard Granite*). This evidently is newer than the normal "Leinster Granite" of Haughton. In the older *Granites*, also in detached intrudes, are

¹ Called *Fellaght fees* in the Co. Waterford.

the newer Granites, which are possibly of Silurian or Devonian age. These younger Granites, for reasons hereafter given, may possibly have some sort of connexion with the great Mineral Channel of the Co. Wicklow.

Wicklow is the premier county in Ireland for mines, not on account of the ores being very rich, but in consequence of the great extent of the mineral ground, and that the mining operations have been in varying activity at intervals from time immemorial.

The great Mineral Channel extends from near the sea, southward of Wicklow, nearly continuously, in a south-west direction, to Ovoca, and from that to the flanks of Croghan-Kinshella, a distance of about fifteen miles. In the Channel, and adjoining it, the rocks are "iron masked," similar to the rocks adjoining the intrude of the younger Granite; this has led me to suggest that this Channel has a possible connexion with the vulcanicity to which the younger Granites are an adjunct. In places along the Channel there were very ancient mining operations.

At Connary and Cronebane, in the EAST OVOCa MINES, there was ancient mining for lead and silver, as has been proved in recent years by the finding of "Old Men's workings," stones—hammers, and other primitive implements. Further south-west, at Moneyteigue, there were other early workings, apparently for iron. Tradition has it, that iron was raised here by the early Irish, and that after the O'Helys were driven out of the country, the Norman knights, Raymond and Sillery, built castles in the vicinity, and worked an iron trade. Towards the end of Elizabeth's reign, the Earl of Stafford (Black Tom), took possession of the county. He, and afterwards his successor, mined and worked iron, through their tenants, or Iron-Masters, the Paynes, the Bacons, and the Chamneys.

The works belonging to the earlier *protégés* of this dynasty cannot be specially mentioned; but between Aughrim and Ballynaclash there are the ruins of very ancient iron works and mines, that are supposed to have belonged to them; as are also others on borders of this county and Kildare.

Bacon, an Englishman, came over and built works at Shillelagh. Before his time most of the charcoal was sent to Wales to be there used in the final working of the iron. He, however, considered it would be more economical to import the pig-iron than

export the charcoal. This adventure was most successful, and at the time of the Commission for examining into the state of the Timber in Ireland, he had amassed a sum of over one million pounds. Having only one child, a daughter, the bait was too seductive to one of the Commissioners, a scion of the twice noble house of Cholmondeley, who became Bacon's son-in-law and successor; relinquishing his heritage, and changing his name to Chamney.¹

The Chamneys greatly increased the trade; having works not only at Shillelagh, where Bacon established the industry, but also in the Vale of Clara; at Ballynaclash, or "Clash," in Glanmalure; at Garrynagowlaun (Woodenbridge) and Aughrim, in the Vale of the Darragh Water; and elsewhere; besides innumerable bloomeries; his works, popularly, being said to have "filled the country." In an old document there are records of some fifty-two or more distinct works in Wicklow, Wexford, and Carlow. The "Clash" and Shillelagh iron was of a very superior quality and at the present day any old chains or other articles made of it are highly prized by the smith.²

Bacon may have only manufactured imported pig-iron; but the Chamneys also smelted the native ores of Ballycapple, north-east of Redcross; and Knocknamohill mines, westward of Ovoca. Elsewhere in Ireland the Iron trade gradually ceased, as the woods were exhausted; but here it seems to have come to a sudden and untimely end prior to 1761, on account of a fracas between Chamney and the English agent of the lord of the soil.³

¹ Although he changed his name during his life, and his descendants adopted the change, yet on his tomb in Carnew Churchyard, his real name and lineage are given.

² A smith who had a forge near Castle M^cAdam, is popularly reported to have gone night after night to abstract the "Clash iron" staples and bolts out of the granite gate posts, so common in the county. Whether he did it or not, the staples now, as a general rule, have all disappeared. I have known a pound of "Clash iron" being exchanged for three pounds of the ordinary iron at present in use.

³ Written information about the old iron works is very hard to procure, as nearly all the Chamney Papers appeared to have been destroyed when the family were dispersed. Old people will tell you that "the noise of the Chamney hammer" was a weather guide, and show you bits of the Clash or Shillelagh iron ore pots; but no one seems capable of giving special information in respect to any of the old works; all say, "I supposed they belonged to Chamney, as they say he had works everywhere." Also they know that the ore and his iron were carried in baskets on horseback from Wicklow port and from the different mines; and the old horse tracks from the mines and Wicklow to the furnace can still be shown. That the trail from Wicklow to Shillelagh must have been a very ancient one, is suggested by its passing the sites of Sillerey's and Raymond's Castles.

The principal ore in the veins of the Mineral Channel is sulphur-ore (*Pyrites*). This in general has a "back," or "gossan," of iron ore, or ochre; while in places between the gossan and the real lode there is a "gossan lode" principally of lead. There are, however, local peculiarities hereafter to be mentioned. Some of the sulphur-ore is coppery, having from two to four units of copper, while in newer lodes there was a mixed ore, in part pyrite, and in part chalcopyrite, that gave from six to ten units of copper. As these mines, at the beginning of the century, were worked solely for the copper in the ores they are generally known as "copper mines," a title to which they are not entitled.

The earliest workings of which we can detect traces were for lead, in East Cronebane, and for iron in Moneyteigue, after which history is more or less a blank till we come to near the end of the last century; for although we know iron was extensively raised, probably in the seventeenth and eighteenth centuries, at Knocknamohill, Ballycapple, and other ores elsewhere; yet we cannot tell exactly at what time or by whom the mines were worked.¹

At the end of the last century the Ovoca mines were in the hands of an English syndicate, who worked them for lead and copper. But early in the present century, the Channel immediately east and west of the Ovoca river seems to have been broken up into five mining setts:—*Ballymurtagh*, *Ballygahan*, *Tigroney*, *Cronebane*, and *Connary*, which were let as "Copper Mines," and when first worked any poor pyrites raised was run into spoil. But about the year 1840, on account of the high price of sulphur, the character of the mines quite changed, as instead of being working for copper they became "Sulphur Mines." While the great demand for sulphur lasted, vast sums were made by the different adventurers; and, as in late years, there was a demand for iron ore, it also was a considerable source of profit. The great demand ceased about the year 1865, and afterwards the mines rapidly declined, and now little or nothing is being done.²

¹ From Boate's history and Petty's maps it would appear as if Wicklow was a *terra incognita*; the first authority does not mention anything in it (the Co. Wicklow), while the second leaves the track a blank in his maps.

² The decline was gradual; the Spanish ore—with its 48 units of sulphur, 3 of copper, and 25 dwt. of silver, also an unlimited supply—gradually drove the Irish ore out of the English market; although for a long time the Irish "Coppery Pyrites"—40

The future prospects of these mines is an important consideration, and the present state of the different setts is therefore of interest. This will be briefly given from the N. E. to the S. W. of the channel.

Southward of Wicklow town, at the north-east end of "The Channel," is the *Ballycapple Sett*, in the townlands of Ballycapple and Ballard. The iron bark of this lode, which seems to have been very rich, was worked in the time of the Chamneys, the ore being carried on horseback to the works at Ballynaclash in Glenmalure. Some of it also seems to have been smelted in bloomeries in the vicinity of the mines, as their sites are still to be seen. From the fragments in the attals, the "true lode" seems to be a coppery pyrite, but it was never worked. Just before the working ceased the miners were driving up from the south an adit to drain the mine. This was recently opened, and was found to end some ten or fifteen fathoms short of the lode. In 1852 trials were made in search of "copper ore," but with what results are not recorded. In 1875 a few tons of iron ore were raised, also brownish ochre, from the back of the lode in Ballycapple Hill. The latter, and the "black stuff" from some of the ancient bloomeries were exported to be used in the purification of gas. Up to the present time only the iron bark and ochre have in part been removed, some stones giving high analysis; they, however, do not represent the average iron ore. The true lode itself, does not appear to have been broken, and its nature, value, and extent have still to be proved.

Between Ballycapple and Kilmacoo, a distance, in a S. W. line, of about three miles, the country is very little known. In it the regular Channel has not been found; but in places there are small veins of copper, sulphur-ore, lead, and zinc. It is possible that the trials made have been too much southward; because in the townland of Rockfield, about a mile N. N. E. of Kilmacoo, is an assembly of "shode stones," very similar to those that elsewhere occur in connexion with the Channel; the Channel may be therefore heaved northward.

units sulphur and 2.50 copper—held its own. As a general rule, the Irish pyrites is much more free from arsenic than the Spanish ore, and therefore more suitable for the manufacture of the pure sulphuric acid.

S. E. of Kilmacree Pass, in the north part of Coolanearl, is an old shaft; but there is no information in connexion with it.

The break a little east of Kilmacoo, or Connary cross-roads, cuts off the Mineral Channel, and heaves it, apparently northward as just suggested. On the Channel between it and the Ovoca river lie the EAST OVOCA MINES. Of these mines an exhaustive description was published, in 1879, by P. H. Argall, formerly agent of the Magpie.¹ They are in two groups—to the north-eastward, *Kilmacoo, Connary*, and the *Magpie*, or *East Cronebane*; and to the south-westward, *West Cronebane* and *Tigroney*.

In the north-east division there are two main lodes, irregularly wedge-shaped, the walls closing in depth on account of the hanging or south wall, standing more perpendicularly than the foot or north wall. The Mineral Channel and the lodes were formerly supposed to have been deposited contemporaneously with the associated rocks, but recent research has shown, that although the general direction of the lodes may be more or less with the strike of the "country rocks," yet the Channel and lodes always cross the latter, though sometimes at a very small angle, while in depth both dip at a greater angle than the "country rocks."

The north lode is principally sulphur-ore, often coppery; it is more or less friable, and accompanied with soft ground. In Connary, south of the lode, there is a massive rib of quartzose rock, with native copper disseminated through it, which is not found in the Magpie. Between the lode and its "gossan" (iron and ochre) there was an auriferous argentiferous lead "Gossan lode," remarkable as in it there were minerals not found in the underlying lode. In Kilmacoo, in old times, there appears to have been an adit that was driven in from the north slope; this, however, has been closed up for years. Between Connary and the Magpie there is a N. and S. left-hand heave, along which there was a lead lode. The lead in the Gossan and Cross lodes was worked in very old times, while the rest of it was abstracted during the present century. Some of the sulphur ore still remains, but not much, as the "Wedge" has been bottomed in different places; it is, how-

¹ *On the Ancient and Recent Mining Operations in the East Ovoca District.*—Scientific Proceedings, Royal Dublin Society, 1879.

ever, possible that, if sunk on still further in depth, the walls might again separate.¹

The south lode occurs in Kilmacoo and the Magpie, it being principally "blue ground," in which are the veins and pockets of *Kilmacooite* or *bluestone*. This peculiar mineral appears to be an admixture of the sulphides of zinc, lead, iron, copper, antimony, arsenic, and silver, with a trace of gold; but it varies greatly and rapidly. It was known in Weaver's time; as the Coppery ore in Madame Butler's lode is mixed with it; while a vein was cut in the "Lodge level." Weaver seems not to have been able to utilize it, while at the present day it cannot be economically reduced. At the present time the typical ore has only been proved in the places above named; but a variety was found in West Cronebane by Argall, and Haughton mentions a variety that occurred in Ballymurtagh, the latter in places being very auriferous (page 10). If, however, the economical reduction of this ore is hereafter understood, it is probably that elsewhere in the courses of "blue ground" it may be found.

A careful analysis of this ore is most important, as, on account of the various constituents and their peculiar relations to one another, hand specimens are very different, some being very rich, others very poor; and unless the greatest care is taken in selecting specimens for analysis, the results may afterwards be most disastrous to the well-being of a mine. This caution is necessary, as the analyses published show that in most cases the ores examined were *picked rich specimens*, which although of interest to the mineralogist, are pernicious to the mine, as they lead to false hopes, which can never be realized. The Magpie has been so-called from the black and bluish-white ground found in the lode associated with the ores.

To the westward of the Magpie, between it and West Crone-

¹ In the deepest working (Williams' shaft, Tigroney) the walls appeared to be again separating. In some of the Cornish mines when the Copper lode had died out, on sinking deeper, tin ore was found. This appears to be a consideration in connexion with the future of these mines, more especially as tin must exist somewhere in the county, having been found in the "streamings" for Gold. Furthermore, in the Magpie shaft the lode in depth was cut out by a Granite protrusion; and, if the lode continues in depth, the mineral contents might possibly change. If these mines hereafter gave new riches in depth, they might be economically worked, by driving up Weaver's deep or "Boat level."

bane, is the tract called the *Yellow Bottoms*, or *Dead Ground*. The latter name was probably given to it in Weaver's time, because the "standing copper lodes" of West Cronebane do not extend into it. In connexion with it are Madame Butler's, and some other mineral lodes; while from explorations made in 1879 and 1880, it would appear that there is also a large sulphur-ore lode, the back of which forms the ochre beds that were worked in 1882, and subsequent years, for the manufacture of paints.

The south-eastern division (*West Cronebane* and *Tigroney*) is cut off by a fault from the Yellow Bottoms, the nature of which has not yet been explained. In connexion with this fault all that can be positively stated is, that the Mineral Channel to the eastward and westward have characters markedly distinct, the lodes having different characters, while some of the minerals found in the first are absent from the second.

The main lode in West Cronebane and Tigroney is wedge-shaped; hard sulphur-ore and some coppery-ore occurring in lamina parallel to the foot wall; while south of it there were "standing lodes"—thin long cake-like masses of coppery-ore. The standing lodes are all worked out; principally in the early part of the present century. The main sulphur lode has been extensively worked of late years, and very little ore now remains; unless it is possible that in depth the wall again separated (*see note, last page*). About 1880 the irony back of a lode was proved in the wood south of Castle Howard; it appearing in the position where the North lode of Ballymurtagh ought to be found.

In the county, north of Cronebane and Connary, are minor veins: one, *Lion's Arch lode*, north of Castle Howard, having been worked profitably between 1870 and 1880 for iron and sulphur-ore. Some of the other lodes might be remunerative if worked in connexion with one of the larger lodes.

A deep level was commenced near the old Glebe in Shroughmore, which was to have been carried south-east till it cut the Connary lode: unfortunately this was not continued, as there are reasons for supposing that it might have cut more than one lode in its course.

Copies of the plans, and sections of the majority of the old and new workings in the EAST OVOCA MINES are lodged in the Mining Record Office, London.

To the west of the Ovoca River are the **WEST OVOCA MINES**, including the two Ballygahans and Ballymurtagh.

Ballymurtagh and Lower Ballygahan are divided from the **East Mines** by a channel of dead ground in the Ovoca River Valley, which heaves (left hand) the latter northward. In these are the North and South sulphur lodes; while south of the latter are the Standing coppery lodes, all the lodes being in character respectively similar to those in the Tigroney and West Cronebane setts. There is a slight left-hand heave near the boundary of Ballymurtagh and Ballygahan. East of this, in the latter, the north lode carried coppery ore only; while in the Ballymurtagh North lode there is a gossan of iron, or ochre, on a rich sulphur lode. Here there was no gossan lode; but in places between the gossan and the lode was a large "vug" full of water. Much of the ore in these lodes is still unbroken.

In Ballymurtagh, between the North and South lodes, there was a shoot of ore, "Pond lode:" this is worked out. In the South lode, Ballymurtagh, the ore has been broken more or less to 110 fathoms below the Margaret level, and in Ballygahan to 70 fathoms below the adit, the deepest working in the first being 24 fathoms below the deepest in the last. At the breast of the workings in Ballygahan, at 60 fathoms, the ore gave 37 units of sulphur, and 4.4 units of copper, the course being over 11 fathoms wide, the south hanging wall not having been reached. Ballymurtagh and Ballygahan would be more profitably worked as one mine; because at any time, on account of the underlie of the South lode, the portion in Ballymurtagh could be undercut by a level in Ballygahan.

In Ballymurtagh South lode there was a lenticular mass of an ore allied to Kilmacooite, it in places being very auriferous.¹

In no place in either Ballygahan or Ballymurtagh has the bottom of the lode being reached; while in both there are good breasts of unbroken ore. Copies of all the plans and sections of these mines are lodged in the Mining Record Office, London.

¹ In Culvert's analysis, in five out of six, there is a return of gold, while in the analysis by Apjohn and others no gold was found. This is another example of the care with which specimens should be selected. Culvert's specimens were from this peculiar ore, which did not represent the true lode, and therefore raised a false hope.

In the Mineral Channel south of the Ballygahan portion of the lode there were Standing veins of coppery ore; but as these were followed westward they joined into the South lode of Ballymurtagh. These coppery lodes for the most part are worked out.

In the county immediately north of Ballymurtagh and Ballygahan there are a great many small veins of sulphur-ore, with a few of lead. Various trials have been made on the sulphur-ore lodes, none of which are of good promise; but some of the lead lodes seem to have been worked by the "Old Men."

Westward of Ballymurtagh, in Upper Ballygahan, Killeagh, and Ballymoneen there are various traces and small veins, on which numerous trials have been made without success, looking for the continuation of the mineral channel in the strikes of the Ballymurtagh lodes. The Ballymurtagh lodes, seem to become poor, as if they approach a left-hand heave; and the trials seemingly ought to have been made more to the south, in the townland of Ballinapark.

Farther south-west are the SOUTH WEST OVoca, or KNOCKNAMOHILL MINES, including the portions of the Channel in Ballymoneen, Ballinapark, and Knocknamohill. Here there also seems to be both North and South lodes. The gossan, or iron back of the first was extensively worked in the Chamney times; and in late years a large "parcel," of ore, was raised to the east, in Ballymoneen ("Hodgson's shaft"). The ore was rich, giving 75 units of iron; but when worked the iron was "cold short." Mr. W. E. Adeney, Analytical Chemist, Royal College of Science, who has lately analysed the ore, states:—"The fact of its going cold short was due to the phosphoric acid; but by the method of Gilchrist now employed, phosphoric acid is no detriment; on the contrary, in ores that contain little silica, as this one does, phosphoric acid is an advantage, and, I think, this ore might be tried by Gilchrist's method with great success."

In these townlands the lode under its iron back (gossan) does not appear to have been broken, and the nature of the minerals is unknown. A shallow level, apparently to drain the Iron Mining, was driven up northward from the mearing of Ballinapark. The Channel and lode to the westward is cut off in Knocknamohill by a fault.

The south lode appears to have been unknown to the "Old

Men." About the year 1840 it was sunk on by Crockford, and some 400 tons of coppery-ore raised; but the adventurer getting into difficulties, the mine was abandoned, and no further work was done.

South-west of Knocknamohill, in the Valley of the Darragh Water, or Aughrim River, there are unknown complications; the Mineral Channel not having been found from where it is cut off by the Knocknamohill N. & S. fault till it is met with again south of the valley, in Ballycoog.

To the south of the Darragh Water are the CARYSFORT MINES. From Ballycoog to Moneyteigue, north of Croaghan-Kinshella the Mineral Channel can again be traced, having in it two or three lodes of sulphur or coppery-ore. They, however, are not continuous, being shifted three or four times, by left-hand heaves.

There were old workings at Ballycoog and Moneyteigue, especially the latter, for iron ore; while in late years various trials were made by the Carysfort and other Companies, some iron and good coppery-ore (8 to 12 units of copper) having been raised at Moneyteigue. In the other places the works were far from satisfactory, as they evidently were entrusted to incompetent hands; and after vast outlay during a number of years, none of the lodes have been proved, except at the surface; consequently their nature in depth is quite unknown.

To the north-west of Croaghan-Kinshella there are mineral indications, but no trials appear to have been made.

To the south of this portion of the Mineral Channel, in the tract south of the Darragh Water, and west of the Ovoca River, various small veins of lead, sulphur, and coppery-ore have been found; but none seem to be of much promise. Some lead ore was raised at Ballintemple, westward of Woodenbridge, but the vein was small.

Although the Mineral Interests in the county, as is so general elsewhere, is now at a low ebb, they must at some time mend. It is, therefore, expedient to give a brief forecast of what may be the prospects along the line of the Mineral Channel.

Ballycapple and Ballard.—The lode under the iron and ochre back unbroken.

Rockfield.—The origin of the "shode stones" still to be traced out.

Kilmacoo and Connary.—The Kilmacooite may become a profitable ore. In depth the walls of the main lode may separate. There is also the chance of a lode being found to the northward between Connary and Shroughmore.

Magpie.—The Kilmacooite may become valuable, and in depth the walls of the main lode may separate.

Yellow Bottoms.—A sulphur-ore lode probably exists under the ochre bed.

West Cronebane and Tigroney.—The walls in depth may separate. The North lode in Castle Howard Wood is totally unbroken.

Ballygahan Lower and Ballymurtagh.—The deep ore in the South lode unbroken. In the North lode only a small portion of the ore abstracted.

Ballinapark, Ballymoneen, and Knocknamohill.—The iron back of the North lode is more or less removed, but the lode appears to be unbroken. The South lode only broken in one place.

Ballycoog, Ballinasilloge, and Moneyteigue.—The lode proved in Moneyteigue, where iron and coppery-ore has been raised; but elsewhere the nature of the lodes have not been satisfactorily proved.

From the foregoing notes it will be seen that there are other places in which prospects are not discouraging. It cannot, however, be said, without further trials, that there is a prospect of these making future mines.

The other mines, also well known, are those on the lead lodes in connexion with the great Granite intrude in the northern portion of the county, they being principally situated in the tributary glens to that of Glendalough and in Glenmalure. Luganure, or the upper portion of Glendasane, one of the branches from the first, being the principal centre of industry.

In the beginning of the century the mines in these and a few of the neighbouring glens were opened up by Weaver, who described the lodes in his Paper read before the Geological Society of London, May, 1818. In 1853 they are further described by W. W. Smyth, vol. i., part iii., *Records of the School of Mines*; but subsequent to the latter there were valuable reports on individual mines by others, especially those by Griffith. Since Smyth wrote, no new lodes seem to have been found, the works

up to late years being on those then known, or on branches from them.

These lodes seem all to have been in the region of the junction between the Granite and Schist, in the first being more or less rich, in the latter in general poor or nearly valueless; while in a few places at the contact there were good bunches of ore. In Glendasan, associated with the *galenite*, were *cerussite*, *sphalerite*, and *pyromorphite*, the lead ores (*galenite* and *cerussite*) giving eight to ten ounces of silver to the ton. Of the numerous veins the largest was that called the Camaderry lode. In late years, on account of the low price of lead, the works gradually slackened off till 1880, when they came to a stand still.

The lead veins in Glendalough were remarkable, being associated with *chalybite* (carbonate of iron), the latter in one place being eight feet wide. The workings on these lodes have been discontinued for years, the lead veins being too small to pay at the low prices for lead.

In Glenmalure there are numerous small lodes, or strings of lead, all of which have been more or less explored. The only mine that gave returns was that at Ballinafunshogue, to the east of the River Avonbeg. This, when in full work, was stopped, the lease having expired, and excessive terms, it is said, being asked for a renewal. The ores in the lode were *galenite*, *barytes*, *sphalerite*, and specks of *chalcopyrite*.

To the west of the Avonbeg, at Baravore, there are appearances of a good lode; but only partially explored. Here *barytes* was in quantity, and of very good quality. In Clonkeen with the lead there was *chalybite*.

Westward of Glenmalure, at the North Prison, Lugnaquilla, is a lode of lead, very favourably reported on by the late Henry Robinson; but it is very difficult of access. Lead also occurs to the southward of Lugnaquilla, at the waterfall, northward of the Aghavannagh Barracks.

Eastward of Glenmalure lead is recorded, at Cullintra Park and at Loughs Dan and Tay, &c. Lewis states the lode at Lough Dan is worked out.

The localities for the gold and tin found in this county are given in the Lists, Part I. In connexion with a "gold digging" there are the *quartz reefs*, the *shallow placers*, the *deep placers*, *dry*

gulch placers, and shelf or bar placers. ["Possibility of gold being found in the Co. Wicklow."—*Proc.*, R.D.S., February 19th, 1883.] In the Wicklow diggings the reefs have been unsuccessfully looked for; while the gold was principally worked in the "shallow placers," and in a few cases in the "dry gulch placers;" but neither the "deep" nor "bar placers" have been explored, at least in modern times. Tin was found in some of the "shallow placers."

Fluorspar is recorded as occurring both crystalline and massive in the Glendalough Mines; but the quantity is not stated. It is now valuable as a flux for iron.

NOTES ADDED IN THE PRESS.

PAGE 6.

Berrycarheen.—The old workings were discovered by Capt. Charles Thomas. The excavation was 60 feet long by 60 deep, and 4 feet wide, between two smooth, well-defined walls. All the stuff in the excavation had been removed by the "old men," as not a trace of it was to be found on the surface.

PAGE 8.

Ordovician.—*Table of Geological Strata.*—When Selwyn and Murchison had finished their independent geological examinations of Wales, it was found that Selwyn's Upper Cambrians were the same as Murchison's Lower Silurians. This led to considerable disputing and controversy; and to prevent this, Phillips proposed that the rocks in dispute should be classed as *Cambro-Silurians*.

This compound name was not, however, received with general favour, many evidently not understanding it. More recently, Lapworth has suggested the name *Ordovician*, derived from the ancient Welsh name of the territory, in which the disputed rocks occur. This name seems to have been more favourably received, and has been adopted by Woodward in his forthcoming second edition of the *Geology of England*; it will also be used in this series of Papers on the *Economic Geology of Ireland*.

PAGE 11.

Tin.—In the placers of the Co. Wicklow, tin has only been found north of a nearly east and west line drawn a little south of the “Red hole,” in the western branch of the Gold Mine River. This led me in the Paper, “On the Possibility of Gold in the Co. Wicklow,” to suggest that the source of the tin should be looked for along this line in the high grounds of Knockmiller and Ballinasilloga; the latter locality had previously been suggested by Mill (about 1803).

As pointed out in the County Histories of Cork and Wicklow, tin may possibly occur in depth at Allihies mines, Bearhaven, Co. Cork, and at Cronebane, East Ovoca mines, Co. Wicklow.

PAGE 51.

Manganese.—Manganese is recorded as occurring in the Co. Antrim: “the most of it occurs in nodules, at the bottom of the soil, on the basalt, with strings in the latter” (*Argall*).

PAGE 65.

Antrim Iron Ore.—The following are analyses of the Glenariff iron ore, forwarded by Captain Argall:—

	No. 1.	No. 2.
Iron peroxide,	62·43 . .	71·64
Iron protoxide,	4·15 . .	1·88
Manganese protoxide, . .	0·28 . .	0·27
Alumina,	10·19 . .	4·25
Lime,	2·80 . .	0·81
Magnesia,	0·59 . .	0·61
Silica,	8·40 . .	5·05
Sulphur,	0·00 . .	0·00
Phosphoric acid, . . .	0·00 . .	0·20
Carbonic acid,	trace. . .	trace.
Titanic acid,	0·00 . .	8·89
Combined water, . . .	1·85 . .	—
Moisture,	3·48 . .	6·40

Mr. Argall directs attention to the Titanic acid in No. 2 specimen.

ECONOMIC GEOLOGY OF IRELAND.

No. II.—**MARBLES AND LIMESTONES.** BY G. HENRY KINAHAN, M.R.I.A., Etc.

[Read, November 17, 1886.]

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INTRODUCTION.

In this Second Paper on Irish Economic Geology, the marbles and limestones are described. They are considered now principally with respect to their value for building and various ornamental purposes. Reference will necessarily be made occasionally to their lithological composition; and we shall sometimes avail ourselves of the opportunities of mentioning the quality of the lime obtained from the limestones by burning. All the quarries, now of much note, are given—besides others formerly worked, and others that might be more generally used than at present. In the Appendix are added other quarries not previously mentioned, besides useful information in connexion with them, and some of the other quarries. The very early builders seem to have preferred sandstone, as, for instance, at the Rock of Cashel, where it was used in the Round Tower and Cormac's Chapel; but at a very early date limestone came into favour, as here, and in similar ecclesiastical settlements, although a few structures are of sandstone, the rest are of limestone. Of late years, limestone seems to have been more in request than any other native stone. This subject will be more fully given in the next Paper on "Sands and Sandstones."

In drawing up the following details we are greatly indebted to Wilkinson's valuable work on the subject, and to numerous correspondents, whose communications extend over a number of years. It seems best not to give the names of any, as we might inadvertently omit some. We, however, return them all our sincere thanks for their assistance.

It appears expedient to give, as an introduction to the subject of the following pages, an epitome of the geological and lithological relations of these rocks to one another, and subsequently classified lists and sub-lists—those classed as marbles being separated from those more suited for cut-stone purposes: necessarily, however, most of the marbles are also applicable for more general uses.

The lists of the marble localities will be as complete as possible, and in them will be included all places where stones have been

worked as marble, whether successfully or otherwise. To these will be added other places in which stones are found that may possibly be hereafter utilized.

Marbles proper are limestones or metamorphosed limestones of a nature capable of taking and retaining a good polish. The metamorphosed limestones belong to two divisions—those that have undergone simple metamorphism, that is, which have only been altered by the action that affected the associated rocks; and those that underwent a second or after change, due to chemical action from without (*methylosis*). These secondarily changed limestones, including dolomytes (*ophiolites*, *ophicalcytes*, *dolomytes*, &c.), are generally called Serpentine; but under this general name are also included chemically-allied rocks (*ophytes*, *eklogytes*, *steatytes*, *pyrophyllites*, &c.), rocks that originally were in general of volcanic origin. It therefore is expedient to include these also under the title of marble, and class them all together, not only on account of their chemical relations, but because all are generally recognised as marbles; and, if separated, would lead to confusion. As they will be hereafter given in separate sub-lists, and their proper relations to one another be pointed out, there will be no incorrect scientific classification.

The marbles will be classified as much as possible according to colour, under the county names, placed alphabetically; while, at the same time, their geological and lithological positions will be kept separate, and each will be described so as to give a general knowledge of the rocks, and the probability of their being of economical value.

The list of the limestone quarries will not be so full, as it would be unnecessary and undesirable to mention all quarries; the nature of the proposed list being to point out as many places as possible where good stones, suited for out-stone purposes, can be obtained, or stones that, from some specialty, are eminently suited to be used in the construction of piers, harbours, or such-like massive works. These lists will be complete, as far as possible: but some isolated quarries, locally, though not generally, known, may be omitted. At the end of each county list is given the general nature of the lime, and other purposes are mentioned to which the stone has been applied. In the counties where lime-

stone is scarce, all localities in which it is found are given, whether they are suitable for out-stone purposes or not.

The geological grouping adopted is the same as that given in the Table of Geological Strata in the Paper "On Irish Metal Mining" (*ante* p. 8).

Some of the recent limestones accumulating at the present time might be utilised in the manufacture of articles of *vertu*. They scarcely, however, come within the scope of this Paper, although it would be incomplete without a reference to them. Such are the stalactytes and stalagmites of the caves, and the massive tufas accumulating in the vicinity of some of the calcareous springs.

Next before these in geological order is the Cretaceous or White Limestone, of a similar age to the English Chalk, but possessing, on account of its induration, a distinct character of its own. This stone is principally quarried to burn into lime, as it is not suited for fine tool-work, being full of concealed cracks and irregular joints. It can, however, be scabbled into stones of small dimension, very suitable for rough masonry. In some places it is ground up, and manufactured into whiting.

The limestones belonging to the Lias are of little note, being only nodules and layers of small dimensions, and apparently of little value, as all attempts to convert them profitably into a cement have, up to the present, failed.

In the Trias there are, in a few localities, massed and lenticular beds of gypsum.

In the Permian beds, the only known calcareous rocks are dolomites. They are so rare, that they have been little utilized, except some near Belfast, which were formerly exported to Scotland for the manufacture of sulphate of magnesia.

In Ireland, the great development of limestone was in the Carboniferous Period. These rocks occupy nearly the whole of the central plain, with ramifications from it, and in some places they exist in tracts that are more or less isolated and of variable extent. In these the characters of the rocks differ greatly, some being nearly pure limestone, while others are argillaceous or arenaceous, often to such an extent as to almost lack the calcareous constituent.

For convenience of description, the Irish Carboniferous Limestones may be subdivided as follows:—

I. The earthy crystalline, or *Lower-Bedded Limestone*.—These rocks are more or less common at the margins of the tracts of the different types of limestone; they are bedded, and in general have shales or clayey partings between the beds, and are often capable of being raised in large masses, but rarely are they eminently suited for cut-stone purposes. As large blocks, they are valuable in the building of piers, foundations, or other massive works.

II. Amorphous or *Fenestella Limestone*.—The latter name has been suggested by Wynne, as the mass of the rock in general is made up of this Coralline. The rock originally seems to have been coral reefs, any bedded portions in it being for the most part above or below, or as isolated subordinate parts in the mass. This rock, in general, is not suited for cut-stone purposes, although some of the included portions, when manufactured, afford beautiful marbles. At the present time, except some few beds, none of the rocks of this type seem to be in much favour with the marble-workers; yet from them our ancestors were able to produce exquisite specimens of art. The work cut from stones of this class in the Geraldine banqueting hall at Askeaton, Co. Limerick, and that, in the chaste and beautiful pillars of the cloisters in the adjoining abbey, cannot be surpassed.

III. *Calp*, or earthy compact limestone.—These rocks are, in general, not good for cut-stone purposes; but they can usually be raised in large blocks, for which reason they are valuable for massive works. Some beds, however, are very compact, homogeneous, and capable of taking a fine polish, and, under such circumstances, have produced first-class marbles.

IV. *Burren type*.—The limestone of this class was so called by Foot on account of its being best developed in the barony of Burren, Co. Clare. These rocks, when typical, are in shades of grey and blue, being crystalline, but compact and free-working; while many beds are suitable for all kinds of cut-stone work. All the chief Irish quarries of the present day are situated in the limestone of this type, and in ancient times all fine workmanship, with rare exceptions, such as the work at Askeaton, was executed in stone of this class. It might naturally be expected

that the principal black marbles should be found in the Calp this, however, seems not to be the case, as some of the world-famed Irish black marbles are from subordinate beds in the limestone of the "Burren type." This, to us, appears to have led to a misconception, as some of the tracts classed on the geological maps as "Calp" are so called solely from their having in them beds of black marble, while, correctly speaking, they should be mapped as "Burren limestone."

It is necessary to explain that the above classification is solely a lithological one, the rocks being arranged according to their general characters, and not to their geological position. The ordinary geological classification has been found, even by those who still use it, to be unstable, as the rock-characters, at first adopted as conclusive of age, being now found to vary according to the circumstances under which the rocks accumulated; purer limestones accumulating in deep water, while littoral and shallow water depositions had peculiar and special characteristics. The rocks of class I. were evidently littoral accumulations; those of class II., the growth of coral reefs or such like; those of class III., accumulations in greater or lesser expanses of shallow, still water, into which fine silt or mud was drifting; while the nature of the accumulations of the rocks of the Burren type is hard to determine, as at the present day there do not appear to be any records of exactly similar depositions.

We have adopted as much as possible the recognised names—a plan which may be, in part, unsuitable to pure geology; but, at the same time, as the geologists of the present day, in respect to Europe in general, and also more or less elsewhere, are colouring their maps, rather in accordance with lithology than geology, it seems allowable for us to adopt the names that are best known and that will be most intelligible, especially when the correct definitions of the names are also given.

Other Carboniferous limestones are those that occur as the basal beds of the Carboniferous rocks, associated with the conglomerates, in the counties of Clare, Galway, and Tipperary. These, however, are of minor importance, and appear to have been but little utilized.

There are also limestones that occur at the margin of the Ordovician (?) or Cambrian (?) metamorphic rocks to the north-

ward of Castlebar, Co. Mayo, which Symes suggests are of Carboniferous age (*Geol. Surv. Mem.*). His arguments cannot be lightly passed over; the principal ones being that these limestone are unconformable to the associated rocks, that they occur in more or less dyke-like masses, and that they are devoid of the characters of metamorphic limestone. An examination of the rocks seems to prove that they must be much more recent than the adjacent metamorphic rock, and that they are of Silurian or Carboniferous, or even of a later age. Symes, after his examination, suggested that they were Carboniferous, and due to the filling in of open fissures, during that period, with Carboniferous matter. It is, however, possible, as has been suggested by myself, that these fissures were filled in by Silurian limestone. To this we shall refer presently. All these limestones are more or less used for lime, some of them being hydraulic.

In the Silurian group (*which includes the rocks that have been called Upper Silurian and Lower Old Red Sandstone*) limestones are rare, and occur in beds of small dimension. They have been recorded in the following places:—At Croaghmartin, in the Dingle promontory, Co. Kerry, are some insignificant arenaceous limestones. In the Co. Galway, at Salrock, Derreenasliggaun, and Leenaun, there are small subordinate masses of limestone, those at Derreenasliggaun being in part somewhat coloured red. Farther eastward, partly in the counties Galway and Mayo, are peculiar limestones, associated with the eruptive rocks that occur at the base of the Toormakeady conglomerate. These rocks are very interesting, as they may possibly be of the same age as the limestone northward of Castlebar, which, as suggested in the previous paragraph, may be either Carboniferous or Silurian. South-eastward of Louisburgh, in S. W. Mayo, there are thin limestones, in part schistose (*metamorphic*). In N. E. Mayo, between Charles-town and Ballaghaderreen, in two places, there are beds of impure limestone; and in the Co. Tyrone, between Sixmile-cross and Pomeroy, there are three or four beds of limestone. These Silurian limestones have been utilized for lime, especially those in South Mayo and Tyrone. Hydraulic limestones occur near Toormakeady.

Limestones in the Ordovicians (*Cambro or Lower Silurians*) are not very uncommon, having been recorded in the Cos. Wicklow,

Wexford, Waterford, Galway, Mayo, Sligo, Donegal, Londonderry, and Tyrone. All are more or less schistose (*metamorphic*), and usually are not suitable for cut-stone purposes; there are, however, some stones in the Co. Donegal, that appear to belong to this group, which have produced excellent work. All these limestones are more or less utilized for lime, some of them being hydraulic.

Limestones of Cambrian age are found in Galway, and probably in Donegal. There are also limestones in the Cos. Londonderry, Tyrone, Sligo, and Mayo, in rocks that may be metamorphosed Cambrians; but the age of these rocks has not been satisfactorily determined. These are all more or less metamorphosed, some also being chemically changed into Serpentine. They are not in general good for cut-stone purposes, but beds both in Galway and Donegal have been worked, and found to dress well; while some have also been worked as marble. The green and variegated Serpentine of West Galway have been worked for marble, and are well known in the market. The more general purpose for which the Cambrian limestones are quarried is the manufacture of lime.

Lime.—As a general rule Irish limestones are suitable for the production of lime, some of them being eminently so. The principal exceptions are found in the Calp, some beds in which are so arenaceous, or argillaceous, that they are rather sandstones, or shales, than limestones. Some of these will not burn at all; others only with great care.

The richest limes are produced by the White and Fenestella limestones, some, indeed, being too rich for sound building purposes, unless they are properly mixed with clay and sand. The limes are almost invariably of a good white colour.

The major portion of the other limestones, as a rule, give more or less dark-coloured limes; while some from the metamorphic limestones, especially those of Ulster, are so dark as to appear more like brick-dust than lime; in general, however, they are good strong limes. Most of those from the rocks of Carboniferous age give a good return, but the returns from the Metamorphic rocks are usually below the average.

The strength and durability of lime made from some of these limestones are shown in ancient, and even modern structures. In

various places, in the ruins of the ancient castles and other buildings, it can be seen that as the buildings came to be demolished, the mortar proved stronger than the stone. This is well exemplified in the old castle in the Flats of the Shannon, near Clonmacnoise, which was built on an artificial clay mound. When the Shannon cut away the clay foundation the castle fell in masses, the weight of the latter breaking through the stones, while the mortar remained unbroken. The Round Tower, Kilmaedduagh, Co. Galway, leans over considerably out of the perpendicular, and has not given way, although some years ago it was struck by lightning, and cracked at the top. A modern example of good work was the garden wall at Cowper's Hill, Queen's Co., built some hundred years ago. This had to be removed, but as both the bricks and mortar were of such excellent qualities, that the wall could not be pulled down without great expense and labour, it was cut into junks, and moved to its new site.

As stated, in some places the limestones are hydraulic. These were used in various waterworks, constructed some years ago, the localities for the different stones being then known; a list was drawn up some thirty years ago by Griffith, but it was never published, and now it seems to be lost.¹

The localities at present known for hydraulic limestones will be given in their respective counties; but these will not embrace all that really exist, as the published records are scant.

The natural cements are not of the same value now as they were formerly; for, as Wilkinson and General H. Y. D. Scott, R. E. (*Proc. Inst. Irish C. E.*, May, 1880), have pointed out, they give uncertain results, one portion of a bed, or accumulation, being so different from those adjoining. This has in a great measure led to the general use of artificial cements, which can be made of a uniform quality and strength. Consequently, the Irish hydraulic limestones have been for years almost entirely ignored.

Scott and others have shown that cement can be manufactured from any limestone if the proper constituents be added. This,

¹ The late Mr. John Byron informed us it was, he believed, destroyed by Griffith, who considered it useless, as "natural cements" (made from hydraulic limestone) had been superseded by artificial cements.

however, requires considerable skill in manipulation, which is only to be acquired in time by careful observation on the part of the workers while making the cement. The great art in making cement consists in getting materials that can be easily and cheaply associated, so as at the same time to produce a good article. Various attempts have been made in Ireland, and although as good as that imported, if not better, has been made, yet the results pecuniarily have not been very satisfactory.

There are, however, some clays in Ireland that might possibly give good results. Near Ballynamona, west of Cong, Co. Galway, there is a clay that was successfully used in the manufacture of cement for the waterworks at Ashford, Cong (*Geol. Surv. Mem.*). Again, the violet-coloured lithomarge found in the "Iron Measures," Co. Antrim, seems to have qualities identical with those of the Pozzuolana of the Bay of Naples. It has not, however, yet been experimented on. There are the muds of some of the estuaries which ought to contain the ingredients necessary for cement, if lime were added to them, or, perhaps, in some cases even without the latter. These also, however, have not as yet been tried, except some in the estuary of the Slaney, Co. Wexford, which are now being employed in the manufacture of a first-class cement at Drinagh, south of Wexford.

Plaster of Paris.—In connexion with the rocks of Triassic age, no limestones, except the supposed Permian dolomytes,¹ have been found, but in some places there are accumulations and beds of gypsum. At Derrynasrobe and Knocknacran, near Carrickmacross, Co. Monaghan, there is a thick accumulation, which has been proved for a depth of 60 feet. Plaster of Paris was manufactured in this neighbourhood, but the works were accidentally burnt down a few years prior to 1870, and since then the manufacture has not been resumed. Gypsum has been found associated with salt near Carrickfergus; also in the valley of the Lagan, Co. Antrim. Dr. Ruttey, in his *Natural History of Dublin*, mentions it as occurring at Multikartan, near Lisburn, and it has also been found at Coagh, Co. Tyrone.

¹ The dolomyte, with Permian fossils, at the Annaghone Colliery, Co. Tyrone, occurs in intimate connexion with the Trias.

The variety called alabaster, suitable for architectural and ornamental purposes, is not recorded as having been found.

MARBLES.

The Irish marbles are not only very varied, but some of them are handsome, and even beautiful. They occur among the Carboniferous limestone and the Metamorphic rocks, the latter being of Ordovician and Cambrian ages. For the most part they are limestone; but some are more or less chemically changed, and are known under the general name of Serpentine. The latter name, however, not only includes the altered limestones and dolomytes, but also certain altered volcanic rocks. The metamorphosed limestones and allied rocks will be more specially mentioned hereafter.

CARBONIFEROUS.

The limestones of Carboniferous age capable of being worked as marble occur in various shades of red, black, grey, and other colours. The red varieties of limestones are rarely of one uniform colour, being usually more or less clouded or variegated. Some of these are beautifully and fantastically marked in lines or clouded tints of grey, white, purple, green, and yellow, and deserve to be much more generally known than they are at present. Some of the black limestones are world-famed, and cannot be surpassed for blackness, or for the beauty of the stone; while others are more or less mottled or spotted with white, generally owing to the presence of fossils. The grey tints graduate from dark to almost white, being often more or less clouded with darker shades, and also with purple, changing them into dove-colour.

RED and VARIEGATED MARBLES.

[RED and VARIEGATED stones are recorded, and have been worked more or less in the Cos. of Armagh, Clare, Cork, Dublin, Kerry, Kildare, Limerick, Longford, and Tipperary, those that have been principally worked occurring [in the Cos. Armagh, Cork, and Limerick.]

ARMAGH.

The marble quarry at Armagh was at one time very extensively worked both for building stones and marble. In the principal bed the colour was a pinkish-grey, which, when polished, was of a warm yellow colour. From this bed large blocks suitable for columns were procured; and associated with it were reddish beds, alternating with whitish. These were quarried for the purpose of being wrought into chimney-pieces and other ornamental work. The rocks formerly raised seem to have been better than those at present obtained; or else tastes may have changed, as now the rocks are considered light in colour and unsatisfactory, and their place has been taken by the Cork and Belgian "reds."

At the present time (*Geol. Sur. Mem.*) there are four separate series of marble—(1) Uppermost are ten feet in thickness of variegated bluish-red stone, in beds from one to three feet thick; (2) A little below these is the *white marble*, a pale, crystalline rock, forming a bed three feet thick; (3) Two feet under the latter is the *shell marble*, a fossiliferous bed, of about one foot in thickness, of a purplish-brown colour, variegated with green and yellow, while nine inches lower is—(4) the *thrush marble*, consisting of ten feet in thickness of a mottled-purplish rock, marked somewhat like the breast of a thrush.

CLARE.

To the south of the Co. Clare, a little east of the Fergus between Newmarket and the Shannon, there are beds in the Fenestella limestone which have been worked as marble, and were used for ornamental purposes in Adare Manor, Co. Limerick, and elsewhere. The stones are red, red clouded with grey, and grey clouded with red. They do not rise in well-shaped blocks, but good-sized stones may be raised which can be scabbled into blocks of fair dimensions.

CORK.

The best Irish "reds" in the market at the present time are procured in this county. They have been worked at Boreenmanagh, Churchtown, and Little Island, near Cork; Johnstown near Fermoy, Midleton, and near Buttevant. These marbles are well known, and have been extensively used. They vary in colour, from a red, like jasper, to streaked and variegated. All except those at Boreenmanagh, Johnstown, and Midleton, are of one type, known in the market as "Cork reds." At Midleton the stone varies from a warm dove-colour to a rich variegated marble, while those at Boreenmanagh and Johnstown are semi-transparent, mottled, or clouded with white and grey.

These stones have been used in the following instances, among others:—The Little Island "red," in the Liverpool Exchange, the Manchester Exchange; Museum, Oxford; St. John's College Cambridge, &c. The Fermoy "red," in the Cathedral, Queens-town; Roman Catholic Church, Thomas-street, Dublin, &c.

The Midleton stone has only lately been known, but it has rapidly taken a place. It is more properly a clouded grey than a true red. It has been used, among other places, in the Manchester Exchange; St. Mary's Church, Bradford, &c.

Cork "reds" have also been used in the Town Hall, Rochdale; Miss Bottomley's, Bradford; St. Mary's, Abbots, Kensington; St. Pancras Hotel and Station, &c.

DUBLIN.

In this county, at Johnstown, there is a red stone which was tried, but it seems not to have been much approved of, and has now ceased to be spoken of.

KERRY.

Near Killarney there is a striped red-and-white stone which has been worked a little, but unsatisfactorily. In other places in the county there are reddish and pinkish stones on which trials have been made, but as yet no good profitable stone has been found.

KILDARE.

At Celbridge is a stone recorded by Sir R. Kane, but it does not appear to have been worked to any extent, and its existence is generally now ignored.

LIMERICK.

Red marbles ("reds") have been more worked in this county than in any other except the Co. Cork. This may possibly be due to the action of the late Earl of Dunraven, who, during the erection of Adare Manor, seems to have searched the counties Limerick and Clare for "reds," specimens of which can be seen in different portions of the edifice, some having been used in outside work, while most of them are represented in the chimney-pieces and in ornamental slabs used for decoration.

In general the "Limerick reds" are clear-coloured, varying from shady or coloured red to variegated, with grey, green, yellow and other tinges; this, however, is not the case in the Pallaskenry rock, which is of the type known as the "Cork reds." This rock was extensively used by Lord Clarina when building his new mansion, and by Lord Dunraven at Adare Manor.

At Clorhane, two and a-half miles north of Adare, half a mile west of Stone Hall, immediately west and north-west of the old church, also half a mile to the west, and half a mile to the south-west of the new church, are quarries which were open and worked during the erection of Adare Manor. In these places, except at Clorhane, the works were of small extent, only a few blocks being removed to be worked into slabs for chimney-pieces. At Clorhane, however, all the "red" was taken away, but some years afterwards the grey stone below began to assume the red colour.

Other places in this county, in which red rocks are recorded, are, a little east of the ruins of the ancient church, to the N. E. of Clorhane Bridge, and in the railway cutting south of Askeaton, a pinkish-greyish stone, in places yellowish, was used for the beautiful pillars of the cloisters of Askeaton Abbey, built by the Earls of Desmond (Geraldines) in the fourteenth or fifteenth century. The exact places where this stone was procured is now unknown, but it evidently came from some place in the neighbourhood.

LONGFORD.

Near Ballymahon, brown red and mottled-grey stones were formerly worked (*Kane*).

TIPPERARY.

Near Dunkerrin are recorded stones of red to purplish colour, veined with yellow (*Kane*); but no extensive works seem to have been carried on. Different marbles appear to have been sought after in this county during the time the marble works at Killaloe were in full work.

BLACK MARBLES.

[*Black Marbles* have been worked, or have been found, in the Cos. Carlow, Donegal (?), Fermanagh, Galway, Kerry, Kilkenny, Limerick, Mayo, Monaghan, Sligo, Tipperary, and Waterford.]

The black marbles of Kilkenny are historic. Although we have in very ancient structures, such as those of Askeaton, Co. Limerick, and Clonmacnoise, King's County, examples of very ancient marble, yet the first written record of Irish marbles seems to be that of Gerrard Boate, written in 1652.

The Irish black marbles were at one time in great request, quarries in various counties being worked in a great measure for exportation to England and elsewhere. The black varieties were principally in demand, but also the black speckled or marked with white. The pure black marbles were chiefly required for monumental purposes, but not always, as a considerable quantity of the Angliham stone, Co. Galway, was exported to London for the Duke of Hamilton's staircase, in his mansion in Scotland. Although in later years the best "blacks" were most in requisition, yet the black mottled or spotted with white, like the famous Kilkenny marble, which got the Irish marbles a name, were much sought after; and also inferior "blacks," the latter being required for local trade in tombstones and such like. Now the trade in "blacks" is very low, none but the best, which have an extensive sale, being much looked for. The black-and-white are not now in much requisition; while the fashion in tombstones of late years has so changed, that inferior "blacks" have now no place in the general market. For these reasons, combined with the gradual depression

in trade, only a few out of the great number of quarries at one time in work are now profitable. The best "blacks" only will be received in the London market: formerly there was a competition for them between it and the American market.

CARLOW.

In the town of Carlow two quarries were formerly worked, one at Montgomery-street, and the other in the townland of Crossnear, the latter being in the suburb called Graigue, west of the river Barrow, in the Queen's County. In the Montgomery-street quarry there were four beds, 7 inches, 2 feet, 3 feet, and 18 inches thick, the thin beds giving the best marble. In the Graigue quarry there was 5 feet in thickness of a stone, that was worked for tombstones, and sent to the Dublin and Waterford markets; and under it were nearly 2 feet of superior black stone. In the Carlow quarry, the limestone over the 18-inch bed could also be used for work of a similar nature. Carlow was once famous for its tombstones, and at the present time the trade is still carried on, very creditable work being sent out from the stonecutters' yards; but it has sadly fallen off from what it once was; this being, in a great measure, due to the fact that sandstone monuments are now most in requisition.

Royal Oaks.—A little more than a mile west of Bagnalstown there is a large quarry, in which marble was procured; and a second further north, nearly a mile south-west of Killinane House. In both these places stones for black marble were, in time past, extensively worked, some being fit for the London trade.

Ballynabrannagh, northward of Milford.—A good black marble was formerly procured in this quarry.

Clogrenan.—There is here a quarry in limestone, immediately under the coal-measures. One bed is a good black, partly spotted with white. It has not been very extensively used. The columns in the hall at Clogrenan House were cut out of this stone.

DONEGAL.

As mentioned by Kane, in his *Industrial Resources of Ireland*, there is in *Kintale*, to the north of Rathmullen, a black bed of limestone that has been worked as a marble. It, however, is of such small dimensions as not to be of commercial value.

FERMANAGH.

Carrickreagh, five miles from Enniskillen.—Not a very good black, but takes a good polish; has been used greatly for tombstones. At various other places there are blackish stones, that have been locally used, but none of those known are of good or even fair quality as black marbles.

GALWAY.

The premier black limestones are now supplied from this county.

Angliham and Menlough.—The marbles from these quarries, which are situated three miles north of Galway, are world-famed, and include some of the best, if not the best, examples of black marble ever known. These were at one time extensively exported to London and America, the stone from one bed being all kept for the London market, from which it has received the name of the *London bed*. Wilkinson, when writing of these quarries in 1845, pointed out that, on account of the eastern dip of the strata, the head over the marble beds was gradually increasing, while the floor of the quarry was becoming of an inconvenient depth below Lough Corrib, both of which circumstances were gradually adding greatly to expenses incurred in removing the superfluous stone, and in keeping the quarry dry. In 1868 there were 40 feet of clearing over the marble beds. At that time, in the Menlough quarry, there were two good beds, one 13 and the other 15 inches thick, below flaggy beds, used for tombstones. At the same time, in the Angliham quarry there were three beds, the *Thin*, 9 inches thick; the *London*, 12 inches; and the *Double*, 14 inches. The *Thin* bed was the purest marble, while the 12-inch got its name from being kept solely for the London market, preference being given to it on account of its capability of being cut most economically. The principal markets were London, Liverpool, Bristol, and Glasgow. At the present time the clearing and pumping have greatly increased, which adds much to the cost of getting the stone.

Merlin Park. About two miles S. E. of Galway.—In this quarry two sets of beds were formerly extensively worked by the

Blakes of Merlin Park, till about the year 1850, after which it lay idle till within the last few years, when it came into the hands of the Messrs. Sibthorpe of Dublin, who have since worked it, the stone being very good, equal to the stone from the Angliham quarry. Quite recently, on sinking below the floor of the old quarry, other black beds have been found, which appear to be of superior quality; but as yet very little can be said about them, as the surface has still to be cleared off. In the quarry there is a clearing of about 25 feet of rock, the upper 17 feet being loose. Under this are three beds of marble, 6, 11, and 15 inches, the two lower sometimes forming one, about 2 feet 2 inches thick. Below the upper marble are about 10 feet of black limestone that lie on three marble beds, 12, 15, and 12 inches thick, while still lower are the new beds.

In *Gortveragh*, north of the Glebe-house, and a mile E. S. E. of Oughterard, there is a fair black stone that was formerly worked by the Martins of Ballynahinch. It can be raised in very large blocks, but at the present time the stone is not favourably received. The old scabbled blocks still lie there, the quarry not having been worked since the Martins' time.

Creggs.—Between the last place and Oughterard there is a bed of black marble, spotted with white, which has not been used except very locally. It is capable of being raised in large sizes, and of taking a good polish. A slab 10 feet by over 5 feet was used for the landing at Lemonfield hall-door.

KERRY.

Good marbles were formerly obtained at *Ballinageragh*, five miles west of Listowel, and also near Tralee. In recent years trials have been made in these places, and elsewhere, but none of the stones were considered suitable for the present demand. The Kerry stone in general is more or less spotted with white, some of it being variegated.

KILKENNY.

Near Archer's Grove, and about half a mile south-east of the town, is the historical *Black Quarry*, with which has been connected the name of Colles for the better part of two centuries. Dr. Gerard Boate, writing in 1652, mentions:—"Besides the freestones

which is in every part of the land, there is marble found in many places, but more about Kilkenny, where not only many houses are built of the same, but whole streets are paved with it. The quarry out of which they have their marble at Kilkenny is not above a quarter of a mile from the town, and belongeth to nobody in particular, lying in common for all the townsmen, who at any time may fetch as much out of it as seemeth good unto them without paying anything for it. . . . This marble, while it is rude as it cometh out of the ground, looketh greyish, but being polished, it getteth a fine brownish colour, drawing somewhat toward the black."

Boate does not appear to be quite correct in saying it was free, as it would appear to have been for years the subject of a suit in Chancery, between the families of Jacob and Minchin, from both of whom Alderman William Colles took leases in 1737, having a few years previously (about 1730) invented machinery, worked by water-power, for cutting, polishing, and boring the marble; and since that time his descendants have had the sole use of it. Alderman Colles' works are mentioned in a *Tour in Ireland*, by two English gentlemen, A. D. 1748, and in Tighe's *Statistical Survey of Kilkenny*, published 1802; while we learn from a recent inquiry instituted by Professor Henry M. Seely, Middleburg, Vt. U. S. A., and published by the Middleburg Historical Society, that Colles was the first to apply water power for the polishing and boring of marble, using it for cutting being in part a re-invention, as in the fourth century of the Christian era stones had been sawn by water-power on the river Roen in Germany.

The Kilkenny marble quarry proper, the "Black Quarry," is close to the river, near Archer's Grove, and about half a mile S. E. of the town; this is supposed to be the quarry mentioned by Boate, and has been worked for at least a century and a-half by the Colleses, the great-great-grandfather of the present proprietor having been the founder of the Kilkenny marble works for the manufacture of chimney-pieces, picture frames, tables, and various other articles, by water-power.

In this quarry there are three varieties: *shelly black*, *pure black*, and *dark-grey*. The shelly black is *par excellence* "Kilkenny marble," the black, with white shells, being world-famed under that name; and in connexion with it was the curious general belief, that the stones when first procured are perfectly black, the

white shells appearing subsequently, being gradually developed when the marble is subjected to heat. But Mr. Colles states this is a fallacy, as he has never known a case in which this occurred, and the fossils are always to be seen from the first.

The pure black is hard and fine-grained, and makes good slabs, a very fine one being in O'Connell's tomb, Glasnevin, Dublin.

At Sion Hill, opposite, on the east of the river Nore, marble was formerly raised, but not of as good a quality as in the Black Quarry, and has not been worked for thirty or forty years, the quarry being now closed up.

At Butler's Grove, near Monefelim, north-north-west of Gore's Bridge, there is a very pure black marble, which at the present time is worked at the Kilkenny works, while formerly it was in great request.

West of Thomastown is a black stone, but not of good quality; it was, however, formerly much used for tombstones, the heavy clearing over it being burnt into lime on the spot, and sold for farming purposes; but since the demand for lime fell off the quarries, like many others, are nearly idle.

LIMERICK.

Good "blacks" were also formerly procured in this county, they being wrought in the quarries, and at the Marble Works, Killaloe, on the Shannon, while the best were exported to London. There appears to have been beds of different qualities, the most valuable being those which were of even texture and free from silix, as the presence of the latter not only made them hard and costly to work, but also less capable of receiving a polish.

At Thomond's Gate, Limerick, a quarry] was formerly largely worked, the famous "Broken Treaty Stone" being a rough block from it. Under the present railway station there was a large quarry, the lowest bed being an excellent black stone fit for the London market, and which was worked up to about the year 1830. Over two miles from Limerick, at Ballysimon, [there were stones of excellent quality, some of the best of which] were sent to London. The beds varied from 7 inches to 4 feet, and 6 feet in thickness the premier bed being one 12 inches thick.

Black marble was also procured at Banks' quarry and Carey's-road; and when the railway was being made from Limerick to Foynes, black marbles were cut at about half-way between St. Patrick's Well and Adare; also near the margin of the marsh between Adare and Rathkeale.

MAYO.

In Partry there is a superior stone, but in so small a quantity that it does not appear worth quarrying. There is also a fair stone near Castlebar, which at present has only been partially tried.

MONAGHAN.

There is a fair black stone, near Glasslough, which appears to have been locally used, but which is not generally known.

SLIGO.

In this county black stones, capable of receiving a fair, good polish, have been procured in different places, but they appear to have been principally utilized for tombstones.

TIPPERARY.

Near Dunkerrin, near Portumna Bridge, and at Castle Briggs, on the Shannon, beds of marble were formerly worked. Stones from the second and third localities were sent by water to the Killaloe Marble Works, but they are not now worked.

WATERFORD.

Black marbles, which were locally used, are said to have been procured at places in the limestones between Lismore and Dungarvan.

GREY MARBLES.

[*Grey marbles* are recorded from the following counties:—**Armagh**, **Carlow**, **Cork**, **Galway**, **Kerry**, **Kilkenny**, **King's Co.**, **Limerick**, **Longford**, **Tipperary**, **Waterford**, and **Westmeath**. They might be procured in different other places if there was a demand for them, but only those with peculiarities are much sought after. Many of the so-called reds are more properly clouded greys.]

ARMAGH.

In the famous quarry for “reds,” the so-called “white marble” is a very light, whitish grey.

CARLOW.

In the Clogrenan quarry there is a crinoidal, fossiliferous stone, somewhat like the famed Clonmacnoise stone, in the **King's County**.

CORK.

The stone at Midleton, although in general classed as one of the “reds,” is more properly a variegated or clouded grey.

GALWAY.

At Angliham, three miles north of Galway, one of the beds worked in the “Black Marble Quarry” is a dark-grey. Near Angliham, in Terrylaw, to the N. N. W. of Mr. Carter's house, there is a handsome grey spotted and speckled stone. This has not been worked as a marble, but a polished specimen is in the Museum, Queen's College, Galway.

About three miles from Ballinasloe is a superior dark-grey stone, capable of being raised in very large blocks and of receiving a fine polish. It was extensively used in Lady Burdett Coutts' markets, London, at East Grinstead, Covent, Chester, &c.

Various grey stones of the Burren type, in other places in this county, are suitable for marble, if there was a demand for “greys.”

KERRY.

In this county trials have been made on “greys,” which have been found very good; but on account of their distances from the market, and from the fact that stones of this colour are not much in request, they have not been utilized, except locally. In colour they vary from a clouded light tint, or nearly white, to dark and blackish.

KILKENNY.

One of the beds worked in the "Black Quarry," Kilkenny, is a dark grey. In the Ballykilaboy quarry, about four miles from Waterford, there is a superior stone, capable of being raised in very large blocks, 17 feet by 5 feet, and 2 feet thick.

KING'S COUNTY.

At the Ballyduff quarry, near Tullamore, there is a very superior stone, of grey colour, graduating into a wan dove-colour. This has been very extensively used in the locality for chimney-pieces and ornamental alabs. It is a beautifully clouded stone in places, and seems well worthy of more public notice than it has as yet received.

Near the Seven Churches, Clonmacnoise, are the well known fossiliferous crinoidal mottled-grey stones, formerly most extensively worked at the Killaloe Marble Works, to which they were brought by water, and still very much used on account of their peculiar appearance.

LIMERICK.

In this county, associated with the "reds," already enumerated, there are "greys," except at Pallaskenry. Some of these reds are in part clouded, or spotted grey, or graduate into grey or dove-colour. The beautiful stone used in the cloisters at Askeaton is, in general, a grey, some parts only being clouded with red or other colours.

LONGFORD.

At Ballymahon a stone has been raised which, when polished, is grey, mottled with red and brown (*Kane*).

TIPPERARY.

Near Dunkerrin there were various trials made for marble. One stone reported, was pale-grey nearly white; and a second a purplish-grey, or dove-colour (*Kane*).

WATERFORD.

In the crags between Lismore and Dungarvan there is a light-grey, nearly-white stone, capable of receiving a good polish; it is said to have been procured and locally used (*Kane*).

WESTMEATH.

At Hall, three miles S. W. of Moate, there is a very good quality of grey stone, splashed with white. In some there are red veins, but this variety is not as sound. It was used extensively at the New Exchange, Manchester, in Bradford, and other places in England.

VARIOUS-COLOURED.

[Various-coloured marbles of Carboniferous age, which cannot be classed with the "reds," "blacks," or "greys," are recorded from Clare, Donegal, Fermanagh, King's Co., and Tipperary.]

CLARE.

At Clondes Lough there is a fine bardilla, or bardiglio marble (*Kane*), a bluish-grey stone, with irregular fine lines and blotches of a dark colour, called originally from Bardiglio, in Italy, where it principally comes from, as pointed out by *Colles*.

DONEGAL.

In Glendowan, westward of Lough Veagh, there is a ribanded Sienna-coloured stone, but so thin-bedded as to be valueless as a marble. It, however, takes a good polish.

FERMANAGH.

In a hill between Castle Caldwell and Belleek is a pale-grey crinoidal limestone, with red spots and circles, due to scattered crinoid stems that are stained with iron. A pillar of it is in the Museum of Trinity College, Dublin.

KING'S Co.

Near Clonmacnoise, *Wilkinson* records "a beautiful marble of Sienna character." It is easily worked, and has been frequently used for ornamental works, and "deserves to be more generally known than it at present is." This stone, although of Sienna character, is not of Sienna colour, it being more of a purplish-clouded grey.

TIPPERARY.

Among the marbles mentioned by *Kane* as occurring near Dunkerron are some of yellow colour, and veined.

METAMORPHIC ROCKS.

The rocks next to be enumerated are probably metamorphosed Ordovicians (*Cambro or Lower Silurians*) or Cambrians, generally the latter.

These marble-bearing stones must be subdivided, as one class was originally limestone or dolomite, while the other was volcanic rock (*exotic rock*), or those allied to them. The latter have to be included, because, as previously pointed out, they, and also certain peculiarly altered limestones and dolomites, are generally classed together under the common name of *Serpentine*, both the limestone and volcanic rocks having undergone a secondary change, due to a chemical action from without, which has been called by the late Dr. King, of Galway, *Methylosis*. The limestones that have only undergone simple metamorphosis (mineralized and micacised) will be classed as metamorphic limestones; while the chemically changed limestones and exotic rocks will be grouped together.

The subdivision of the Methylosic rocks is of such recent date that, from the available records, it is hard to accurately subdivide them unless all the localities were personally revisited. The subdivisions given hereafter are therefore in part only suggestive; but, as far as possible, they will be correct.

In the list will have to be mentioned rocks that are not at all likely ever to be of commercial value as marbles. This, however, appears necessary, as some of them have already been given a greater value than they deserve; and, on this account, it is desirable to mention them.

All of these stones, that are also suitable for out-stone purposes, are a second time mentioned in the lists of the limestone quarries.

METAMORPHIC LIMESTONES.

The rocks that come under this class—with the exception of the peculiar Sienna-coloured stone in Galway and Donegal, and the black from Kintale, Co. Donegal, and Carricksheedy, Co. Londonderry—are white, or shades of white, some handsome stones being tinted or clouded with grey, pink, or green. All are more or less schistose. Some are thin-bedded, those that are massive generally rising in more or less rude, unshapely blocks. The stones are for the most part coarsely crystalline, and consequently not able to compete with the Italian stones; while those of a creamy character, as far as has yet been discovered, are also disqualified, owing to their being either too thin-bedded or jointy, which prevents them being raised in blocks of sufficient size.

On this account many hand-specimens show a beautiful stone equal to any elsewhere; while, in the quarry, these stones are found to be of such small dimensions as only to be suitable for the manufacture of articles of *vertu*.

This to me seems a most important fact, to which too much attention cannot be directed in Papers on the Economic Geology of the country.

What might be highly productive industries have been already destroyed by false statements in reference to them.

In the following lists some localities for good stones have been omitted—those to which our attention has been called will be given in the Appendix.

WHITE and RED MARBLES.

[Sometimes tinted, or clouded, with grey, pink, or green; in general coarsely crystalline; rarely fine-grained and compact.]

DONEGAL.

In the promontory of Fanad, north of Kindrum Lough, and immediately west of Lord Leitrim's lodge, is a white stone, partly coarsely crystalline and in part compact. It has not been opened into; but a specimen from the surface gave unsatisfactory results.

Immediately east of the south arm of Sheephaven, in the townland of Drumlackagh, is a considerable thickness of limestone of white to grey tints, some of it being massive, the rest flaggy. Its qualifications for marble have not been tested.

To the eastward of Dunfanaghy, at Marble Hill (Glaisheen), the stone is white or rose-tinted. It is capable of receiving a good polish—crystalline and slightly schistose.

At Ballymore, four miles from Dunfanaghy, there is a creamy-white stone, in places clouded with brown or having brown portions. It polishes well, and has been worked as a marble of a pleasing character.

At Kinclevin, nearly a mile from Dunfanaghy, there is a greyish-white stone not very promising.

Lewis mentions a superior "white marble" in the Rosses, "capable of being raised in large blocks." This ought to be somewhere to the north of Gweedore; but the locality has not been satisfactorily localized.

Six miles E. S. E. of Gweedore Hotel, at Dunlewy, there is a large limestone quarry. The stone is white to creamy-white, tinted with green and pink. It has been used both as building-stone and as marble. The "whites" are coarse, but durable; the others are beautiful stones, but so thin-bedded and jointed that it is impossible to raise them, except in pieces of small dimensions, which renders it of little commercial value. As the quarry has been worked only along the surface of the bed, rarely twenty feet deep, it is possible that better stones might be got at some depth, especially at the western end.

At the base of the range of hills north of Fintown are white limestones favourably reported on. No trials, however, have been made on them.

A little south-east of Glenveigh Castle, a surface trial was made on a white, highly crystalline limestone. Enough of it is not seen to form an opinion; but the rock appears worthy of making a more extensive opening on it.

In the parish of Gartan, on the west shore of Lough Akibbon, and two miles north of Church Hill, is a white, greyish, and pink-tinted stone. It polishes well, and has been approved of by the marble-workers; but further and more extended trials are necessary to prove whether it can be raised in blocks of profitable size.

In the townland of Magheranan, to the east of Letterkenny, is a nice-looking white stone, spotted with green, that has not been opened up, and its qualities are unknown.

In the hills north-east of Kilmacrennan, near the village of Ardanawark, are white and pinkish rocks that can be raised, it is said, in large-sized blocks. No trial has been made on them; but a specimen polished easily and well. They appear to be in the same beds as those at Lough Akibbon.

Three miles south-east of Letterkenny, in Magheraboy, is a nice-looking, white, untried stone.

About a mile east of Convoy, at Kiltale, there is a white stone of good appearance, but thin-bedded.

In various other places in the gneiss district (Cambrian) of Donegal are small detached masses, or beds, of white, or clouded-white crystalline limestones; but as none of them seem to be of a magnitude or quality to form a "quarry," it appears unnecessary to enumerate them.

GALWAY.

To the south of Letterfrack, in the hill of Creggs, are white limestones. One portion is a stone of "excellent quality, equal to the Italian, but it rises in small blocks" (*Sibthorpe*). After some time spent in sinking on this vein, *Dr. Ritchie* of Belfast failed in getting good-sized marketable blocks.

On the western shore of Derryclare Lough there is a quarry, formerly worked by the *Martins* of Ballynahinch, who seem to

have raised some fair-sized blocks ; colour white, tinted with grey. In the lake in White Island there is a very peculiar stone, white, spotted with green Serpentine crystals. This rock is associated with green ophialyte ; no opening has as yet been made in it.

South of Adrehid Lake, and in a second place, to the westward of Glengowla Mine, both a little west of Oughterard, there are white crystalline rocks, that have not been tried as yet.

There is also an untried fair-looking white limestone north-west of Ross Lake, between Oughterard and Galway.

LOUTH.

In the Carlingford promontory white crystalline limestones have been found in three places, but of such limited extent, that it seems improbable that they should ever be of commercial value.

SIENNA-COLOURED.

DONEGAL.

In Glendowan, westward of Lough Veagh, *M'Henry* records a ribanded Sienna-coloured stone, that polishes well, but it is too thin-bedded to be of much value. In its layers there is a structure like *Eozoon canadense*.

GALWAY.

At Lough Auna there is a maculated Sienna-coloured stone of limited extent (see page 402).

BLACK MARBLE.

[Black stones in the metamorphic rocks fit for marbles are only recorded in the Cos. Donegal and Londonderry.]

DONEGAL.

At Kintale, a mile and a-half north of Rathmullen, *Kane* records a stone capable of being used as a marble. It appears to be only very locally known.

LONDONDERRY.

At Carricksheedy there is a black stone capable of taking a good polish ; it appears, however, to be only locally known.

METHYLOTIC ROCKS, or SERPENTINES.

The name Serpentine is more applicable to the methyloitic limestones than to the methyloitic volcanic rocks. We will, however, here use it in the broad popular sense, and include under it all the methyloitic limestones and volcanic rocks, also the rocks allied thereto. Of late years Lithologists have greatly subdivided these rocks, the principal subdivisions of the former being called ophiolites, ophicalcytes, and ophidolomytes; and of the latter, ophyte and eklogyte, with the allied rocks steatyte (*soap-stone*) and pyrophyllite (*cam-stone*).

Dana divides the massive Serpentine or ophyte into *precious Serpentine* of a rich old green colour, of pale or dark shades, and translucent, even when in thick pieces; and *common Serpentine* of dark shades of colour, and subtranslucent. The latter is hard and difficult to work on account of impurities. Many statues however, in Egypt and India are made of rocks of this class. Eklogyte is still commonly called Serpentine. Formerly steatite and pyrophyllite were also thus classed; now many separate them. Steatyte and pyrophyllite are still confounded together by most people, their appearance being very similar; yet they are chemically very distinct, the former being a silicate of magnesia, and the latter a silicate of alumina. Steatyte seems to be always an adjunct of volcanic rocks, while the other occurs in general as a bedded rock: steatyte, however, may occur as "fault rock," if the latter had been made up of volcanic rock *debris* or volcanic tuff.

METHYLOTIC LIMESTONES AND DOLOMYTES.**OPHIOLYTES, OPHICALCYTES, and OPHIDOLOMYTES.**

The rocks of this division now of commercial value are recorded only in the west of the Co. Galway, and are known as *Connemara greens*. They have indeed been found also in the counties Donegal and Waterford, but from neither of these counties do any stones come into the market, while the beds or veins seem to be so limited in extent that there does not appear much prospect of their ever doing so.

The "Connemara greens" are most varied in colour. Some are dark-green, uniform, or clouded; others are leek green or light green; while the majority are mottled or spotted, or streaked and variegated. These last are very happily described by Sir C. L. Giesecke, who wrote near the beginning of the century. "It is impossible to describe the immense varieties of delineations and shades and colours of the beautiful stone which attracts the eyes of the beholder; the serpent-like (*i. e.* wavy formation) delineation of some of them must excite particular admiration. Others are coloured in spiral forms; others are dotted and spotted with different shades of grey and yellow."¹

**GREEN, or VARIEGATED, or STREAKED with GREY,
WHITE, RED, YELLOW, PURPLISH.**

GALWAY.

The ophiolites occur in one group of strata which were once continuous, but now, on account of the breaking-up of the rock by faults, the exposures are more or less disconnected and isolated. The most northern exposure occurs as an isolated mass at Loughnagur range, two miles south of Barnaderg, or Ballynakill Harbour. The rocks are uniform, clouded, and variegated green. The stone has not been worked in this locality. The nearest harbour to it is Barnaderg, with which it might easily be connected by a road.

At the west end of Streamstown Bay, or about two miles north of Clifden, are different exposures of ophicalcyte. On a vein a little east of the end of the bay is the quarry formerly worked by the D'Arcys of Clifden, and of late years by Mr. Colles of Kilkenny. The stone in general is variegated with spots or streaks; green, grey, and white predominating. The scabbled blocks are carted to Clifden for shipment.

In the eastern continuation of the Streamstown Bay valley, occupying a narrow tract over three miles long, which extends from Loughauna to Loughnahillion, is a nearly continuous band of these rocks. Here there is a great variety, both in beauty and colour, as

¹ *Trans. Royal Dublin Society*, vol lxii., March 2, 1826, Appendix.

exhibited in the ornaments manufactured by the M'Donnells of Clifden—self-taught artists—who manufacture brooches and various other articles of *vertu* by hand, out of ophiolytes from these and all the other localities, to dispose of them to visitors. One unique and beautiful variety on sale by Alick M'Donnell was a maculate Sienna-colour ophiolyte from a vein at Loughauna. To work the stone in this valley, that to the westward, near Loughauna, could best be approached by a road constructed from Streamstown Bay, from where it could be carted to Clifden for shipment; while that at Loughnahillion would be brought more easily by a road northward to Barnaderg Bay.

To the south and south-eastward of the valley last mentioned, and nearly parallel to it, is that of the Owenglin; where, in occasional spots for a distance of over three miles, the ophiolytes appear. They are, as elsewhere, most varied in colour and beauty, while in some of the streaked varieties the structure that has been called *Eozoon canadense* occurs. In this valley, at Barnaoran, are the famous "Ballynahinch Marble Quarries," from which, in old time, most of the Connemara marble was obtained; and it was of the stone seen here that Giesecke wrote. Of late years these quarries have got into disrepute, on account of the severe road from them, a steep ridge intervening between Owenglin and Ballynahinch, over which the blocks had to be carted. This stone was used in the new Museums at Oxford and Trinity College, Dublin. A small vein of a peculiar variety (*Onkosin*) occurs to the east of Barnaoran; it is of a pale olive greenish grey colour, full of dendritic markings, and having an appearance somewhat like moss agate. This, under the name of "moss serpentine," was extensively worked by Alick M'Donnell, who discovered it. A very fine specimen is in the Museum, Queen's College, Galway.

The blocks of stone from this valley have to be drawn across the ridge to the Ballynahinch valley, and from thence to Cloonisle pier for shipment; they might, however, be manufactured by water power at the quarries.

Extending southward, at nearly a right angle from the east end of Owenglin, is Glenisky. Here the serpentine occurs in veins that continue southward from those in Owenglin, along the western slopes of Bengower, past the summit of Benlettery, terminating on the south slope of the latter. The stones are very similar

to those in Owenglin, but with them are also found smaragdite schist. The place is difficult of access; because Glenisky, leading down to Ballynahinch, is steep and rugged. Blocks might, however, be run down an incline, or the marble might be worked in the glen by water-power. The south end of the glen is about five or six miles from Cloonisle pier.

In the south-east slope of Benlettery there is the small east and west valley called Derrynagloan, where there is a small vein. This is of easy access from the Ballynahinch road.

Extending northward from the east end of Ballynahinch lake is Glencoaghan. Here are found, in different places, detached exposures of serpentine, the largest occurring at, and southward of, Bennaderreen, on the western slope of Derryclare hill. The other exposures are between this and the lake. The stones are very similar to those in Glenisky. No quarry as yet has been opened; nor is there a cart road into the glen, but one could easily be constructed, which would pass by all the exposures. Canal Bridge, at the mouth of the valley, is about seven or eight miles from Cloonisle.

Veins of serpentine occur in places along the north-east portion of the south-east shore of Derryclare lake, and also in the islands. Here, especially in White Island, the rocks appear to be more varied in colour than elsewhere, one being very peculiar, having in a whitish ground long, crystal-like pieces of dark green. Most of the veins are at the water level, and, if they were worked, there would be a certain amount of expense in pumping. The blocks, however, might be carried by water down the lake to Canal Bridge, and even down Ballynahinch Lake to the river near Toombeola, where they would be only a short distance from Cloonisle.

Farther eastward, to the northward of the Recess Hotel, on the south-west and north-west slopes of Lissoughter, are various detached exposures of serpentine. On the south-west slope, close to the village, is a quarry formerly worked to a slight extent by the Martins of Ballynahinch, but much more extensively during the last fifteen years by the Messrs. Sibthorpe of Dublin. This stone is, in general, uniform, or clouded green, some being dark, but at the same time translucent. Very good-sized stones have been raised, but in rough, unshapely blocks. The stone, however, is of

such good quality, that it has been found more profitable to carry them unsquared to Cloonisle for shipment than [to square them in the quarry.

At the time the Messrs. Sibthorpe began working, about the year 1870, there was a considerable demand for "Connemara greens"; but unfortunately for the reputation of the stone, as also for many other marbles, architects would insist on using them in outside decorations, and, consequently, not through any real inferiority in the stones, they soon weathered and became unsightly. Thus was generated a most undeserved prejudice against the green marbles, which, when used in [their proper sphere as inside work, cannot be surpassed in beauty or elegance.

The largest column yet obtained (9 ft. 9 in.) was wrought out of a block raised in Lissoughter. It [is now at St. Anne's, Co. Dublin, the mansion of Lord Ardilaun. In England this marble was used at the Manchester Exchange, Rochdale Town Hall, St. Mary, and other places in Bradford; St. John's College, Cambridge; St. Mary Abbot's, Kensington; St. Pancras Hotel and Station, &c. Recently it is being exported to America, there being a greater demand for the uniform and clouded dark-greens than for any of the others. From either the Lissoughter or Bar-naoran quarries was procured the serpentine, by the Martins of Ballynahinch, that was wrought into the chimney-piece presented to George IV., and now in the Carlton Club, London.

METHYLOTIC EXOTIC ROCKS.

(OPHYTE, EKLOGYTE, STEATYTE, AND PYROPHYLLYTE.)

DARK-GREENS, and VARIEGATED.

The ophytes, as a general rule, may be classed as "dark-greens," although some are of light colours, or spotted, mottled, and streaked. None of them appear to answer fully Dana's definition of "Precious Serpentine," as they seem in general to occupy a position between that grade and his "Common Serpentine." None of them are in the market, although they are equal to, and perhaps even surpass, some of the foreign stones.

They are not, comparatively, of rare occurrence, being recorded in seven counties, while probably they will be found in others, as until recently it has been customary to group them with the associated pyroxenic or other volcanic rocks, of which they are methyloitic adjuncts. Thus, in the counties Wexford and Wicklow, it is only recently that these distinct rocks have been separated on the maps.

As far as the records can be depended on, these rocks are, in almost all cases, found associated with the old metamorphic rocks (*Ordovician* and *Cambrian*). One exception, however, has been mentioned, as ophyte is found as an adjunct of the *Carboniferous* rocks of the Co. Limerick. Here the tract is of such small dimensions and the rock so inferior in quality, that it might be ignored were it not for the exceptional circumstances under which it has been found. It is quite possible, however, now that attention has been called to the circumstance, that it may be found elsewhere associated with even younger rocks.

Eklogyte is in aspect very like ophyte, and by most geologists they are classed together. It has therefore been only recorded in two counties, although probably it also occurs elsewhere. It is allied more or less closely to saussuryte, or Swiss jade. Some of the ancient implements known under the general name of "celt" were manufactured out of rocks of this class.

The steatytes or soapstones are in colour very pale-grey, or bluish, or greenish, or greyish-white, while others are reddish or orange. Some of them are very suitable for the manufacture of articles of *certu*, but as far as we are aware they have not been so utilized.

Pyrophyllite or camstone may be counted as a new class of rock; for although given its proper place in mineralogical books, in geological writings it has almost invariably been called steatyte, or a "coarse variety of steatyte"; consequently the records of its occurrence are few. For years it has been recognized in the Co. Donegal, and has been used in some of the ecclesiastical structures. A rock that appears to be pyrophyllite is also recorded in the Co. Cork; while patches and veins or beds occur in the blackish slates of Ordovician age in the Co. Wexford. In other places, if it exists, it has been classed with steatyte. It probably occurs in the Co. Galway, as hereafter mentioned.

OPHYTES.

[Dark-green to blackish, some striated and spotted. Occur in the Cos. Galway, Mayo, Sligo, Tyrone, Waterford, Wexford, and Wicklow.]

GALWAY.

To the north of the townland of Leamnaheltia, near the south shore of Lough Fee, in the mountainous tract north of Kylemore Lough, is an isolated mass of ophyte of dark, and in places lighter clouded greens. Some pieces of this rock were worked by Alick M'Donnell of Clifden, who stated "the rock was very kind."

At Dawros, to the east of Ballynakill Harbour, and a little north of Letterfrack, there is an extensive tract of dark-green, nearly black, ophyte.

To the south and south-west of Garroman, or Glendollagh Lake, are small tracts of dark-green ophyte.

Near the shore of Galway Bay, about half a mile south-west of the ruins of Bunowen Castle, is a small tract of dark-green, nearly black, ophyte.

In the mountainous tract of Errisbeg, to the westward of Roundstone, are three rather long tracts of ophyte. Two are near Lough Bollard, while the third is a little more than half a mile to the east of it. The stone in general is dark-green, but some of it is mottled, dark and light.

MAYO.

Two miles north of Castlebar there is a long narrow exposure of dark to light-green ophyte.

Along the northern slope of the Croagh Patrick range, from near Louisburg to some miles east of Westport, is a long wide-tract of ophyte associated with steatyte. To the westward it thins out, while its greatest thickness appears to be at the railway cutting a mile and a-half south-east of Westport. Some surface-specimens were experimentalized on and were found difficult to cut; but it might improve if opened in depth; it appears worthy of trial, as it varies much in colour, from greenish-black to dark-green, light-green, reddish, and purplish; some of it being handsomely streaked with the colour last mentioned.

In the hills between Leenaun and Wespert, two or three miles north-west of Sheeffry, at and south-west of Lugaloughaun, are three or four exposures of a peculiar rock that appears to be allied to ophyte; they are of different shades of light green. These rocks work easily, but it is questionable if they could be procured in large blocks. The place at present is very inaccessible.

In Glencullin, north-east of Mweslrea, is a dyke of mottled-green rock allied to ophyte, or eklogyte (?).

SLIGO.

At Slishwood and the valley running nearly south from Bunowen Bay, Lough Gill, is a band nearly two miles long and about five hundred feet wide, of a dark-coloured, compact, somewhat hard ophitic rock. It contains magnetite, especially to the westward, where Hardman states it "possesses all the characters of natural magnets." It also contains some nickel. The rock is of a splintery nature. Although called a serpentine, it possibly more correctly should be classed as an eklogyte.

At Drumahaire, three miles north-east of the Slishwood serpentine, there is a band about three hundred feet thick of very similar rock, except that it is not "perceptibly magnetic."

Close to Shanavan's Bridge, near Manorhamilton, is a third band of similar rock, supposed to be about a mile long.

In the *Geology of Ireland*, p. 191, it is suggested that these rocks were possibly metamorphic Cambrians or even Laurentians. It now, however, appears to be much more probable that they are in part Cambrian, and in part Ordovician.¹

TYRONE.

Westward of Cookstown, to the north and north-west of Pomeroy, are the hills in which Slieve Gallion is the principal

¹ If the markings found near Lough Finn, Co. Donegal, and exhibited by Dr. Hull at British Association Meeting, 1886, are graptolites of Arenig types, as appears to be very probable, the supposed Laurentians of Donegal are unquestionably metamorphosed Ordovicians, Arenigs, and Cambrians. Consequently, it is probable that the rocks of Sligo, and also the similar rocks of Cos. Tyrone, Leitrim, and Mayo, are also Cambrian, Arenig, and Ordovician.

summit. These, for the most part, are composed of highly altered rocks that have been suggested to be of Laurentian age; but, as previously mentioned, are more probably metamorphosed Arenig. In them, towards their south margin, are tracts of ophyte, generally dark olive-green, approaching to black, but some are of lighter colour or variegated or streaked.

About three miles north-west of Pomeroy, west and south-west of the lake that lies half a mile west of the summit of Cregganconroe, are four distinct patches of ophyte; while a little to the west, on the hill called Scalp, is a fifth. At Athenree, about a mile and a-half S.S.W. of Scalp, and a mile south-east of Carrickmore or Termon rock, there is also a tract, and another about half a mile W.N.W., of Carrickmore. In the last, the rock, in places, has a decided variegated or streaked colour. Some of these stones have a good appearance, and seem to be qualified to produce a marble. As yet, none of them have been utilized or even tested.

WATERFORD.

In this county the serpentines recorded are only of very small extent. As, however, the rocks of the eastern portion of the county are similar to those of the adjoining counties of Wexford and Wicklow, and as among the latter ophyte only recently has been recorded, it formerly having been included among the pyroxenic rocks, it seems not improbable that here, as in Wicklow and Wexford, there may be small tracts of ophyte still unrecorded. This, however, has still to be examined into.

WEXFORD AND WICKLOW.

The presence of ophyte was not recorded in these counties until within the last five years, although "serpentine" is mapped on the old geological six-inch maps. This, probably, is due to the fact that, until recently, many geologists classed them with the pyroxenic rocks, of which they are metholotic varieties. They are now known to occur in the following localities:—

On the north and south slopes of the western spur, extending from Croaghan Kinshella, in the townlands of Cummer, Cummer-

duff, and Hillbrook, some of them being on the borders of the counties of Wexford and Wicklow, are detached exposures of ophyte. They are of various shades of green, generally dark-coloured.

South-west of the spur of high ground last mentioned, and a little west of Carnew, in the Co. Wicklow, there is a tract of dark-green ophyte, in places spotted with red, like a bloodstone. It is capable of taking a good polish.

Much further northward, about half way between Anamoe and Togher or Roundwood, is a large boss of dark-green ophyte.

EKLOGYTE.

[Speckled and mottled, green and brown, recorded from Galway, Mayo, and Sligo.]

GALWAY.

To the W. N. W. of Kylemore Castle, in the townland of Currywongaun, there is a vein of greenish-brown speckled eklogyte. A small opening was made by Mr. Mitchell Henry, M.P., who had some of the rock cut and polished at his saw-mill.

A little south of Garroman or Glendollagh Lake, in the mass of ophyte previously mentioned, is a pipe vein of spotted bright-green eklogyte.

MAYO

A little south-west of Ballyhean, on the north slope of Tonderrew, there is a mottled light-green eklogyte. The rock in this locality is very like the previously-mentioned rocks near Lughaun and in Glencullin (see *Ophytes*, page 158), and it is possible that the rocks in these places should be classified with the eklogytes, and not with the ophytes.

SLIGO.

The rocks previously described among the ophytes, at Slishwood, Drumahair, and near Manorhamilton, seem to partake very much of the nature of eklogyte, and possibly ought to be so classed.

STEATYTE, or SOAPSTONE.

[Some are pale-grey, of bluish and greenish tints ; others reddish or orange. They have been stated to be found in the Cos. Donegal (?), Galway, Mayo, Sligo, and Waterford. As the question of the classification of steatyte and pyrophyllite is still obscure, rocks said to be steatyte will be mentioned under this heading, coupled with the objection to their classification.]

DONEGAL.

In different places associated with the basic volcanic rocks are seams of steatyte, but of very small dimensions. In other places, the rocks that are generally called steatyte are more probably pyrophyllites. No large mass of true steatyte appears to be recorded in the Co. Donegal.

Near Crohy Head, westward of Dunloe, Mr. Blake states there is a steatyte so pure as to be valuable for the manufacture of lubricators. It occurs as a bedded rock unassociated with intrusive rocks, and is probably a pyrophyllite ; but this has still to be verified.

Eastward of Dunfanaghy, at Ards, steatyte is also said to have been found. The rock, however, appears to be pyrophyllite.

GALWAY.

Steatyte occurs in subordinate veins and patches, associated with many of the intrudes, especially the ophyte ; but they are of small dimensions. It has also been recorded as found near Kilmeelickin chapel, in the Maum valley. The specimen, however, would suggest that the rock was a pyrophyllite.

MAYO.

On the south shore of the island of Bofin and the north shore of the island of Shark, in this county (but off the coast of Galway), are considerable tracts of fine light to darkening-grey steatyte ; the better portions being of a silver-grey. On Bofin it has been worked to some extent, and exported for the manufacture of lubricators, but apparently not for articles of *vertu*.

In the mountainous tract between the Killary and Clew Bay, to the westward of Doolough, there is a considerable mass of an impure yellowish steatyte, an adjunct to a felstone intrude.

Associated with the long ophyte mass of the Croagh Patrick range, there are steatytes of greater or less extent in different places.

WICKLOW.

To the eastward of Croaghan Kinshella, in the townland of Killahurla, there are in places dykes of a reddish or orange friable steatyte. None of these have been opened in depth.

PYROPHYLLYTE, or CAMSTONE.

[Pale greyish-green to dark-green. When cut and polished some are of a rich olive-green. They are only recorded in the Cos. Cork (?), Donegal, Galway (?), and Wexford.]

CORK.

In the Carboniferous slate, to the south-west of Castletown Berehaven, are beds or dykes of a pale-yellowish stone that are probably pyrophyllite or an allied rock; they, however, require further examination.

DONEGAL.

In this county camstone appears to have been recognized for years, although in the records it has been called "a coarse or impure kind of steatyte"; and has even been mined and sent into the market as steatyte. Years ago it was used for architectural purposes, as in the ancient churches of Balleekan and Killydonnell south and north, respectively, of the western arm of Lough Swilly, where, when the Old Red Sandstone mullions of the windows decayed away, they were replaced by new ones cut out of camstone. In Balleekan there are also tombstones of a somewhat similar class of rock. Where this stone was procured is now unknown. Wilkinson, writing in 1845, states that in the mountain range, near Kilmacrennan and Barnagh are camstones that "can be cut or turned with facility into any form," and "are very durable," but the localities are not given, and no quarries in this stone appear to have been worked for years, or can now be pointed out in those neighbourhoods. It is, however, known to occur in the following places:—

About two miles N.N.W. of Castlefin, at Gibbstown, is a quarry

from which camstone appears to have been procured rather extensively in former years; at present it is only raised to be used for hearths or the backing of fire-places.

In places between Raphoe and Letterkenny camstones have been found, but they seem to be only used for local purposes.

In the townland of Cabrabrook, E. S. E. of Church Hill, is a camstone that appears to have been quarried formerly, but for years the quarry has been filled up.

In Carrowtrasna, west of Lough Akibbon, and over two miles northward of Church Hill, is a bed that has been mined by Mr. Duckworth for some years, and sent to Liverpool, to be used in the manufacture of lubricators; but on his death a few years ago the industry was abandoned.

Beds of camstone associated with limestone can be seen in different places in the hill country westward of Kilmacrennan, but it does not appear to have been worked recently except to get clay for hearths. At Cloonkilly there was a large working; it is probably the locality referred to by Wilkinson

There is a bed or beds to the north and north-east of Ramelton and in the neighbourhood of Carn it has been worked along the surface to obtain fireclay.

Westward of Rathmullen, in the townland of Meenreagh, there is a bed of camstone.

LIMESTONE QUARRIES.

[The quarries will be arranged in the counties placed alphabetically under their geological group. Generally only the quarries that give stones fit for cut-stone purposes will be mentioned, except in counties where limestone for burning is scarce, under which circumstance all the localities are given. In some localities, where quarries are scarce or altogether absent, limestone boulders are found in the drift, and are collected along the sea-coast, river, and streams; while in other places sea-shells are carried inland and burned. Tradition says that lime made from sea-shells was used as a medicine.]

ANTRIM.

In this county there is no Carboniferous limestone except what occurs as subordinate beds in the Ballycastle coal-field; and in these no quarry of any note seems to have been worked.

The Cretaceous, or White Limestone, occurs round the margin of

the great field of Cainozoic dolerites, principally near the coast-line. Many quarries have been opened in it, generally to procure stones for lime. As the White Limestone is for the most part full of irregular cracks and joints, it cannot be finely tooled or procured in large blocks; it can, however, be scrabbled into fair-sized stones suitable for rough building. A house built of the White Limestone, with quoins and dressing of the black dolerite, has a clean but quaint appearance.

In pre-historic times the chalk flints were extensively manufactured into weapons and other articles in the county, or were exported into the neighbouring counties. Subsequently they were manufactured into gun-flints. The latter trade has now died out, although still found profitable in parts of England.

The white limestone in general gives a good and cheap lime. It is largely quarried, and exported to the opposite coast of Scotland for the purpose of burning.

At Larne and Glenarm the white limestone is extensively manufactured into whiting.

ARMAGH.

A limited tract of Carboniferous limestone occurs across the north portion of the county. In general it is of an earthy character, inclined to be shaly, and blackish-grey in colour, except at Armagh.

Armagh.—Light pinkish grey, yellowish, and shades of red. This stone, when polished, gives out a warm yellowish colour; but when dressed with the tool it is whitish. It is used as marble, and both for rubble and cut-stone purposes. Blocks of large size, suitable for columns, have been obtained, while the thinner beds of red shades have been made into chimney-pieces and other ornamental work. Formerly these quarries were very extensively worked (see *Armagh Marbles*).

Navan. A mile from Armagh.—Dark, dull, grey, earthy; rather difficult to work.

Excellent lime is abundant at Armagh, and a good lime, made from the white limestone of Co. Down, in the neighbourhood of Lurgan and Moira, is also much used.

At Benburb, adjoining the Co. Tyrone, there is a compact blue stone that makes hydraulic lime. It was used in the construction of the Ulster Canal.

CARLOW.

In this county the greater portion of the Carboniferous limestone is a dark iron-grey dolomite, of a frail nature. Near the town there are limestones of the Calp type, some of them being in good blocks. The quarries in the latter locality have been worked more for the marble than for building-stones. These quarries have been already mentioned (see *Black Marbles*).

Browne's Hill. A mile north-east of Carlow.—The stone in general is dolomite, full of drusy cavities (geodes); but one bed, between 4 and 5 feet thick, consists of grey, compact, and fine-grained stone, capable of being dressed.

In general, the limestone of the county burns into excellent lime.

CAVAN.

Very little good limestone for building purposes can be obtained, except at the extreme south of the county, near Lough Sheelin. Formerly some quarries were open here, but now all stone is procured from the Ross Castle quarry, close by, in the Co. Meath. Near Cavan some small quarries have been opened, but the stone is not generally valued for tool-work.

Belturbet.—Light to dark-grey, fine, crystalline, but splintery; thick and thin-bedded. Tools fairly. From this vicinity were procured the stones to build Crom Castle, on Lough Erne, Co. Fermanagh.

Mount Nugent.—Quarries were formerly worked in this vicinity on a stone of good quality. They are now closed up, as all stones required can be more easily obtained from Ross Castle, Co. Meath.

A fair, strong lime is made from the Cavan limestone. In the southern portions of the county most of the lime is procured from the neighbouring counties.

CLARE.

Throughout most of the barony of Burren and in the country near Ennis, there are large tracts of bare rock. The stone is of the Burren type, and is, in general, of excellent quality; but some beds are much out up by joints; others, however, are not, and from these stones of great dimension can be procured. As the

limestone can be worked on the surface in so many places, very few quarries have been opened: the stones procured at some depth are, however, much more easily worked than those obtained at the surface.

Rosslerin. One mile from Ennis, where the stone is extensively used.—Dark-grey, semi-oolitic, crystalline, and close-grained. Works freely: but as the stones are of small dimensions they are procured at Bushy Park when required for larger size.

Bushy Park. Over two miles from Ennis.—Somewhat like the Rosslevin stone, but can be raised in much larger blocks.

Kilfenora. Over six miles from Ennistymon, where the stone has been largely used.—Grey to dark-grey. Rather difficult to work. The great durability of the stone of this neighbourhood, and its capability of being used in fine work, is seen in the ancient crosses and the cut-stone work of the ecclesiastical ruins. Ancient work in Burren stone can also be seen in the ruins of Corcomroe Abbey, near Ballyvaughan. In connexion with the latter, the tradition in the country is, that the stones were procured in a cleft south-east of the summit of Moneen mountain, called "Scalp-na-Shesbia," but this seems to be a natural ravine, and due to weathering.

In the south and south-east of the county quarries have been opened in various places for local purposes. South of Newmarket-on-Fergus there is a quarry in a red or reddish-grey stone, that was used in the building of Adare Manor, Co. Limerick; it has also been worked for marble.

The stones of this county make excellent and cheap lime. Along the south-west coast sea-shells used formerly to be burnt for lime.

CORK.

In comparison with the extent of the county, there is not much Carboniferous limestone in it. It principally occurs in the valley of the Lee, near Cork, and thence eastwards to Youghal; also in the valley of the Blackwater. Many of these stones are remarkable for their beauty. Macaulay has made the beautiful stone of which the Courthouse of Cork is built historical.

Aherla. About nine miles north of Bandon.—Light-grey, platy, very easily worked; can be sawn with advantage, and large

flat stones can be procured. On account of the great ease with which this stone can be raised and worked, it is cheap, and has a considerable sale, even in Cork, nineteen miles distant.

Ballintemple and Carrigmore.—Three miles from Cork. Light-grey, close, even-grained, and compact; works well and freely. This stone has been used extensively in the public buildings in Cork; among others in the Courthouse, as mentioned by Macaulay. The capitals of the columns of the portico are well executed.

Haulbowline.—Light-grey, not very easy to work; can be raised in large blocks. Used in building the new docks.

Little Island.—Light-grey, close-grained, and compact; works freely. Was extensively used for the fortress at Spike Island.

Carrickacrump and Ballyfin.—Near Cloyne, and about twenty miles by water from Cork. The stone is carted to Aghada for shipment. Very similar in character, except as regards colour, to the Ballintemple stone, with which it does not contrast well. The Bank of Ireland in Cork was built of stone from this place. It can be raised in very large blocks, and can be more easily sawn and worked than any other limestone in the neighbourhood of Cork Harbour. Ballyfin is about a mile from Carrickacrump, and the stone there has not been as largely worked.

Fermoy.—Light bluish-grey, compact, but of variable texture.

Ramaher (Kanturk).—Grey, compact, very fossiliferous; not easy to tool, on account of the fossils.

Midleton.—Greyish-blue, inclined to reddish, compact, semi-crystalline, uneven in texture. Has been worked as a marble.

Shanbally. Near Carrigaline.—Light-grey, of a flaggy nature; an excellent stone for rubble work; not so good for dressed work.

Fairlane. Near Mallow.—Light-grey, compact to splintery; close-grained; works fairly.

Drishane. Two miles north-east of Millstreet.—Grey, compact, but in places having drusy cavities; works fairly well; quarried very largely for lime.

Carraundulkeen. Three miles south of Kanturk.—Dark-grey, crystalline; semi-compact; works well; very largely quarried for lime.

In the limestone areas the lime, as a rule, is excellent and cheap. At Kinsale there is a bad lime brought into the town. In places along the coast sea-shells used formerly to be burnt.

The dolomytes of this county have been utilized for the manufacture of fluid magnesia.

DONEGAL.

The areas of Carboniferous rock are of very limited extent, the largest being that in which Donegal and Ballyshannon are situated. At Pettigoe there is a little strip outside the mearing of Fermanagh. There are, however, in various places among the metamorphic rocks (Ordovician and Cambrian), beds and patches of the older limestone. Some of these are well suited for cut-stone work. The cut stone in the little church of Glenalla, near Rathmullen, is from Dunlewey, and has a remarkably good appearance, and seems to be durable. The white and shaded whites, of which there are many varieties, are capable of being polished, and might be worked as marble; but almost invariably they are more or less coarsely crystalline; or when fine-grained and compact, they are thin-bedded and full of joints, preventing their being raised, except in small pieces. These causes deteriorate their value, and prevent their being able to compete with the Italian stone.

In the Metamorphic Rocks (Cambrian (?), Arenig, and Ordovician) limestones occur at the following places:—

Ballymore. Four miles from Dunfanaghy.—Creamy white, in places clouded with brown, or having brown portions; highly crystalline; polishes well. Has been used as a marble. Difficult to work, but an excellent material for all cut-stone purposes.

Marble Hill or Glaisheen. Two and a-half miles from Dunfanaghy.—Pink and white, of a delicate colour, but with imbedded clouds of grey; crystalline and slightly schistose.

Rock Hill.—One and a-half miles from Dunfanaghy. Whitish-grey, slightly crystalline, in parts pyritous and micaceous, making the stone liable to discolour.

Rinclerin.—Nearly a mile from Dunfanaghy. White, with greyish tint; highly crystalline; fracture smooth.

Dunlewey. Six miles E. S. E. of Gweedore.—White and pink-tinted creamy white; blue, and green-tinted. At the western end of the seam there was a hard, white crystalline rock, very durable, as seen in the church close by, where it has not even lost colour. This stone was not followed in depth. The creamy and tinted varieties in the eastern portion of the quarry are in very thin beds,

and are so broken up by joints that they cannot be raised except in very small pieces.

Lettery. Over two miles from Glenties.—Light whitish-grey, silicious, and micaceous. In this vicinity are other quarries from which similar stones can be procured.

Fintown. To the north of Lough Finn.—White to greyish crystalline.

Glenveagh. A little south-east of the Castle.—White : highly crystalline. Only the surface of this bed has been opened. Here it is friable and much cut up by joints. Stone untried in depth.

Lough Akibbon (Garton). Over two miles north of Church Hill.—White and pinkish, solid, fine, crystalline; polishes well; seems capable of being raised in large blocks. Appears to be an excellent material for all cut-stone purposes; but as yet the quarry has only been very partially tried.

Drumlakagh. Nearly three miles eastward of Creeslough.—White and grey-tinted; crystalline; thick and thin-bedded. Could be raised in fair-sized blocks. Not at present worked, except for lime.

Ardanawark. Two miles north-east of Lough Salt, in the hills north-east of Kilmacrennan.—White and pinkish, highly and coarsely crystalline. Can be raised in large blocks. Appears to be well suited for tool-work, but at present only worked for lime. Polishes well and easily.

Magheraboy. Three miles south-east of Letterkenny.—White to pinkish; very crystalline. This stone seems to be totally unworked, although, from its appearance, it ought to give good lime, and be suitable for cut-stone purposes. As it is near Letterkenny, in which neighbourhood there is no stone of any kind suitable for tool-work, this seems worthy of a trial.

Cloghroe. Two and a-half miles from Stranorlar.—Bluish-grey and white; crystalline; partly schistose.

Cullanacon. Two miles west of Convoy.—Greyish-white and pink-shaded; crystalline; thin-bedded, with schistose partings.

Kiltole. Nearly a mile east of Convoy.—White to pinkish; compact; crystalline. A good stone, but thin-bedded.

Maghera-sollus. A mile E.N.E. of Raphoe.—White and greyish-white; compact; crystalline; thin-bedded, with schistose partings.

Crauford. Four miles northward of Milford, on Mulroy Bay.—Light to dark bluish-grey; compact to shattery; crystalline; in part schistose; makes excellent lime.

Kindrumlough. A little west of Kindrum Lodge, in Fanad-within-the-Waters.—White to creamy white; coarsely crystalline to compact; shattery, but seems to be suited for tool-work. As yet untried. Surface-pieces polished well, but were shattery and facial.

Tamney. West of Croaghan House.—A dolomite of a Sienna character. Untried, but appears too gritty and irregular to be of much value.

Kintale.—A mile and a-half northward of Rathmullen, on Lough Swilly. Bluish-grey, in part earthy and in part micaceous. Works easily; can be raised in large blocks. One black bed has been locally used as a marble.

Hill Head. Four miles from Carndonald.—Dark blue to grey; finely crystalline. This stone has its peculiarities; because when first raised, it is soft and crumbly, but afterwards it hardens into a good stone.

Various other detached masses occur also in different places in the hills, but it is unnecessary to enumerate them.

Good or fair stone in the Carboniferous is recorded as follows:—

Ballyshannon.—Brownish-grey to dark greyish-blue; earthy; compact; semi-crystalline; works freely.

Donegal.—Greyish-black; very earthy, the calcareous matter being very small. Not much used.

The *Carboniferous* limestones near Donegal and Ballyshannon burn into a good lime. The older limestones *Ordovician* and *Cambrian*, are very generally used, the lime being nearly invariably dark-coloured, but strong. Some of the white varieties, however, give a white lime. A peculiarity of some of these limestones is, that when they are used as road-metal, the road becomes plastic in continuous wet weather, becoming again quite hard when it is warm and dry.

Down.

This is one of the Irish counties in which there is scarcely any Carboniferous limestone. It occurs only in a small tract at Castle Espie, two miles south-east of Comber, and in the extreme south

end of the county at the entrance to Carlingford Lough. The stone at Castle Espie is worked solely for lime.

At Cultra, on Belfast Lough, a little Carboniferous limestone, associated with Permian dolomyte, occurs below high water-mark.

Cretaceous, or the White Limestone, occurs in the west of the county, in the north-west slope of the valley of the Lagan. It is worked largely for lime in the neighbourhoods of Moira and Lurgan. It is too brittle and jointed to be finely tooled or procured in large blocks, but it can be squared by scabbling into blocks suitable for rough masonry.

Lime in this county is scarce, most of it being imported. It is procured from the Carboniferous limestone at Castle Espie, and from the White Limestones of the Lagan Valley. In places on the coast sea-shells were formerly burned into lime.

The Permian dolomyte of Cultra, on Belfast Lough, was formerly utilized by being exported to Glasgow for the manufacture of sulphate of magnesia.

DUBLIN.

Nearly all the limestone in this county is more or less of the Calp type, and varies greatly in character. In general it is only suitable for rubble-work; but as it can be raised in large sizes it is valuable for foundations. Some beds make good lime, while adjoining beds may not burn at all.

The best stones occur near Lucan and Leixlip, near the mearing of the Co. Kildare, from whence they were procured for the Custom House Docks. Calp limestone was also used in the building of the old church in Mountjoy-street and the old Christ Church Cathedral, while the latter was repaired by Calp brought from Rathgar and Kimmage. For many of the old buildings the stones were so badly selected, that they are now weathered into rotten shaly or earthy masses.

In the north part of the county there are stones of a coarsely-crystalline character, not well suited for tool-work, but capable of being raised in very large blocks.

Milverton.—This and other quarries occur in the neighbourhood of Skerries. Grey, coarsely crystalline, compact, and even-bedded. Rather hard to tool, and not well suited for fine work; but, on account of its strength and the possibility of procuring it in large

blocks, it is suitable for massive work. From this were obtained the large cap-stones for the pillars of the Boyne Viaduct. They were also extensively used in the construction of the Lighthouse on Rockabill.

Donnybrook and Miltown.—Here formerly were extensive quarries, principally in the river and to the eastward of it, but now they are very little worked. Dark-grey to blackish, earthy; suited for foundations and rubble-work, but not for cut-stone. It was, in a great measure, the use of the Donnybrook Calp in repairing the streets that got for Dublin the *soubriquet* of “dear, dirty Dublin.”

Rathgar.—From pale to dark-grey and blackish; from thick-bedded to good flags. This quarry was once extensively worked. The ordinary stones were good for rubble-work, and the flags of a very fair quality. The best beds, being nearly equal to the “Carlow flags,” were extensively used.

Kimmage and Crumlin.—The stones in these quarries are more or less similar to those at Donnybrook, Miltown, and Rathgar. These supply to a great extent the rough and foundation stones now required in Dublin.

Ballymacaully and Collierstown.—On the Royal Canal, between Leixlip and Lucan. From these quarries were taken the stones to build the Dublin Custom-house docks. Formerly very extensively quarried.

Lime from the Calp is, in general, dark-coloured and inferior, some beds being, however, very good. A great deal of the limestone used in Dublin for lime is brought from the neighbourhood of Slane, Co. Kildare. The Howth stone is hydraulic (*Wilkinson*).

At the present time the limestone which appears to be most approved of by the Dublin builders is the Ballinasloe, Co. Galway, stone, which can be seen in the Hibernian and Munster (Head-office) Banks; next to it the Tullamore, King’s County, the latter being much in request for monumental purposes, and was used in the monument at Glasnevin to the late Under-Secretary, Mr. Burke. The Ardbracon stone, Co. Meath, although it has a good appearance when finished, is soft, and does not keep its colour; and with it is classed the Ross Castle stone, Co. Meath; but the stone from the neighbouring quarry at Crossagh, although coarser, is more favourably thought of. The Milverton stone, near

Skerries, works easily, but is full of vorts and defects. The Sheep-house stone, near Drogheda, was used in the restoration of Christ Church Cathedral, although it has the reputation of being of a soft, poorish class.

FERMANAGH.

In the centre of the county, forming the valley of the river and the two loughs Erne, there is a considerable tract of Carboniferous limestone; but in some places the stone is of a bad quality, not being even fit for lime-burning. Where good stone does occur, it is not as much sought after as in other counties, the sandstone being of good quality, and very generally used for dressed work. In the erection of Crom Castle, the seat of the Earls of Erne, limestone from Belturbet, Co. Cavan, was used; but the quoins and dressings are of sandstone. Most of the public buildings in Enniskillen, as also in the other towns, are built of limestone.

Kinarla. About a mile and a-half by water from Enniskillen.—Dark-grey; not a sound stone; was used in building the church and part of the Roman Catholic church in Enniskillen; also by the Ordnance Department.

Derrygon. Half a mile from Enniskillen, on the lake shore.—Dark-grey, compact, good quality; used in the gaol and the new bridge built by the Drainage Board.

Mullaghree. Two miles from Enniskillen.—Light-grey, sound, tough, fiat-bedded.

Carrickreagh. Five miles by water from Enniskillen.—Dark-grey to black, of excellent quality; polishes well; has been used extensively in Enniskillen; lately in the new cemetery church, and as quoins and dressings in the Roman Catholic church; also used for tombstones.

Kesh. One mile from the town.—Dark-grey, fairly compact, even-bedded, with shale partings; used in the railway bridges and in the buildings of the neighbourhood.

Ederny.—Similar stone to that at Kesh; Market-house built of it.

Belleek.—At the Falls. Dark-grey, crystalline, compact, and close-grained; used in building Belleek Works.

Lisnaskea.—Dark-grey, good, sound, well-bedded stone, but

difficult to work with tools, owing to layers of chert in it. The Market-house and Railway Station are built of it.

Newtownbutler.—Bluish-grey, semi-crystalline, compact, earthy; Market-house built of it.

During the recent works for the drainage of Lough Erne they excavated into a dark compact limestone at *Belleek Ford*, which was used in the works thereabouts; while the new west bridge of *Enniskillen* is built of the stone quarried while cutting away the *Portora Ford*.

Some of the limestones are too earthy to burn into lime, but good strong lime is plentiful and cheap in the county, the best stones being procured westward of the lakes. A stone at *Castle Caldwell* gives a hydraulic lime.

GALWAY.

This county produces excellent limestones, suited for all out-stone purposes; they belong both to the older formations and to the Carboniferous. In the older formations (*Ordovician* and *Cambrian*), there are stones suitable both for tool-work and marble, in shades both of white and green. Those of green colours are unsurpassed elsewhere as marbles; but the whites, on account of their coarseness or other peculiarities, have not a forward place in the market. All these stones except the greens are more or less burnt for lime, some being better than others.

At *Salrock*, *Derreenasliggaun*, and *Leenaun*, in the north part of the county, there are *Silurian* limestones. Some of those at *Derreenasliggaun* are reddish, and have been used as a marble.

The *Carboniferous* limestones occupy all the eastern portion of the county, being nearly altogether either of the *Calp* or *Burren* types, principally the latter. Those of the *Burren* type are most conspicuous in the long tract that to the north enters the county from *Mayo* at *Lough Mask*, and extend southwards to *Galway*, and from that to the barony of *Burren*, *Co. Clare*. In these crags, in numerous places, superior rocks can be obtained; and the surface rocks in many places are worked; but necessarily they are not as easily tooled as in places where a quarry has been opened. They are of different shades of grey and blue, with subordinate black beds. From the latter some of the best black marbles in the world have been obtained.

The limestones of this portion of Galway, as also of the adjoining parts of Mayo and Clare, are so eminently suited for all cut-stone purposes, that now, as in former years, they are used to the exclusion of all other stones, although in the neighbourhood of the town the granites are unsurpassed in beauty, variety, and quality.

The great durability of the Galway limestone, and the delicate workmanship of which they are capable, are displayed in the various old ecclesiastical structures about the country, and also in the eleventh-century buildings in the town of Galway; which are still very perfect, notwithstanding the rough usage to which they have been subjected. Some of the pillars and other fine work in the Abbey of Knockmoyne, Ballyglunin, are still most beautiful.

The best stones of Ordovician and Cambrian ages are recorded at the following localities:—

Streamstown. About two miles north of Clifden.—Variegated and streaked green; worked for marble.

Creggs. About four miles east of Streamstown.—White to creamy white; and coarsely crystalline to compact and fine-grained; eminently suited for delicate cut-stone purposes, but cannot be procured in very large blocks; has been worked for marbles.

Clifden. In the vicinity are limestones.—Bluish-grey or dove-coloured; more or less schistose; and difficult to work.

Barnaoran.—The “Ballynahinch marble quarries,” in the valley of the Owenmore. Green and variegated; worked for marble. The colours of the stone are very delicate and fugitive, which makes it unsuitable for any outside work.

Derryclare. Adjoining the lake.—White, or with a greyish tint; crystalline; compact; easily worked; but rises in unshapely blocks, which causes a waste in dressing. Was quarried some years ago by the Martins of Ballynahinch.

Lisoughter. Near the village, one mile from Recess.—Green and variegated; solely worked for marble.

Other stones of shades of green and white are already described in the lists of Galway marbles.

Of the innumerable Carboniferous limestone localities, the following may be specially mentioned:—

Galway.—To the north-east of the town, between it and Men-

lough, are extensive crags. The portion at the surface has been worked in different places, wherever the stone took the fancy of the stonecutter. A few quarries have been opened. Whitish to grey and blue, with subordinate black beds; crystalline; compact; fine-grained. Suitable for all kinds of cut-stone work; while the black beds are superior marble. It would appear as if a remunerative trade in their stone to England and elsewhere might be developed, as the limestone is of such excellent quality, while the freight ought to be low on account of so many ships, trading to the west coast, having to return in ballast.

Angliham and Menlough. About three miles north of Galway.—Worked for the marble beds.

Two-mile Ditch. Two miles from Galway.—Bluish-grey; crystalline; uneven-grained; easily worked.

Gortveragh. About one mile E. S. E. of Oughterard.—Dark-grey to black. Formerly worked by the Martins of Ballynalinch for marble. In this vicinity, and north-westward to Oughterard, there are good stones in various places suited for tool-work. A quarry was formerly worked in Creggs, from which good black stones were procured, one forming the flag at the hall-door of Lemonfield House, the seat of the O'Flaherties.

Arran Islands.—Great sheets of limestone of different shades of grey and blue; superior stone. On the north island, or Arranmore, some of the beds are of considerable thickness, and without joints for lengths of 150 feet to 200 feet or more, out of which great monoliths might be procured.

Newtown. Two miles from Gort.—Bluish-grey; close-grained; fossiliferous; works freely.

Ballyleigh, near Gort.—A fine black stone, formerly worked as a marble.

Castleboy. Between Gort and Loughrea.—Bluish-grey to grey; not difficult to work.

Craughcell. Seven miles from Loughrea.—Bluish-grey; an easily-worked stone.

Brackernagh, Ballinasloe.—Light to dark-grey; close-grained, crystalline; hard; an excellent stone; polishes well; can be raised in large blocks; worked as a marble; used very extensively in Dublin for all kinds of cut-stone purposes; carriage, in waggon loads, about 7s. 6d. per ton.

Workhouse (Ballinasloe).—Slight bluish-grey, crystalline, compact, hard; a good stone; difficult to work.

Kilroe.—Nine miles from Tuam. Bluish-grey; close-grained, semi-crystalline; splintering in fracture; works well. From here were procured the blocks for the cut stone for the Roman Catholic Cathedral of Tuam.

Workhouse (Tuam).—Bluish-grey, crystalline, uneven-grained: smooth fracture.

Cong.—In the vicinity of Cong, in the counties Galway and Mayo, there are extensive crags of excellent stone, capable of being procured of any size, and the stones of some beds taking a good polish. It is suitable for all cut-stone purposes. The cut-stone work in the ancient abbey at Cong attests its durability, and the fine class of work it can be applied to. Some of these stones are capable of being split into long beam-like masses, suitable for bridges, for which purposes they have been used.

The Carboniferous limestone gives an excellent lime. The Silurian limestones at Salrock, Derrynasliggaun, and Leenaun, do not appear to have been much used, while the metamorphic limestones give a strong dark-coloured lime, but a small return. For this reason, in the west and north-west of the country Carboniferous limestone is generally procured either from the Arran Islands or from Clew Bay, Co. Mayo. In old times sea-shells were burned for lime along the Connemara coast.

KERRY.

The Carboniferous limestone occupies a considerable area in the eastern portion of the county, including a small isolated tract near Kenmare. It is of various characters, being cleaved or slaty near Kenmare, while to the north it partakes of the characteristic both of the Calp and Lower limestone, except at the Lakes of Killarney, where, in general, it is more or less slaty like that of Kenmare. This slaty stone was used in the building of the Abbey of Muckross, and furnished some very well-finished work. Limestone of Ordovician age occurs on Caherconree in the Dingle promontory.

In the Carboniferous the stones best known are as follows:—

Kenmare.—Grey and blue; slaty; difficult to work across the beds; can be made into good jambs, window-sills, and such-like, especially if sawn across the grain.

Lisavigeen and Cahirnagher. About three miles from Killarney. —Grey, crystalline, even-grained, hard, but works well. These quarries chiefly supply Killarney with all cut and rubble stone.

Listowel.—Dark-grey, compact, earthy; works freely. This quarry has been largely worked for years, supplying stone to all the neighbourhood. The upper beds are a bad-class stone, but the lower are fit for any purpose, and with care can be raised of large sizes.

Ballinageragh.—Six miles west of Listowel. Dark-grey to black. Good for all out-stone purposes. One bed black, mottled with white, was formerly worked for marble.

Rathos (Tralee).—A coarse, cherty stone, but useful for rough squared work.

Ballymacelligot.—About six miles from Tralee. Bluish-grey, close-grained; partly earthy; free-working; has been very extensively used in Tralee in the public and private buildings.

Good and cheap lime is made from the Carboniferous limestone. The Ordovician limestones of Caherconree, Dingle promontory, are also used for lime.

KILDARE.

Although most of this county is situated in the great Carboniferous tract of the central plain, none of the limestones that have been quarried are particularly well suited for out-stone purposes, the best stones being procured near Celbridge and Leixlip, adjoining the Co. Dublin—stones that have been already described. Here, as elsewhere, all the quarries that have been opened are in stones of the Calp type, except those near Slade and Sallins, which, however, have been almost entirely worked for the purpose of being sent to the Dublin market for burning into lime.

Lime is very plentiful and good, the Calpy stone being in general burnt, or else boulders got in the Drift. At the Chair of Kildare there are Ordovician limestones, which are also burnt; but the lime from the Carboniferous limestone is preferred.

KILKENNY.

In Kilkenny there is a considerable area of Carboniferous limestone, the rock in many places being of a class fitted for all cut-stone purposes. The ordinary stone is usually in shades of dark-grey and blue, varying from close-grained to open-grained,

very tough, but working freely. It is very durable and strong, as exemplified in the different ancient buildings, as well as in the more modern structures. Almost everywhere it can be procured in whatever sizes may be required. Wyley has pointed out that, in Jerpoint Abbey and elsewhere, where a slight pillar had to support a great weight, limestone was used in place of sandstone. Associated with the ordinary limestone are creamy dolomytes. These have been, in general, ignored by the modern builders, but some of them, at least, are good and durable stones. In the base, and notably in the jambs, of the doorway of the Round Tower of St. Canice, Kilkenny (9th century), this stone was used, intermingled with sandstone. They have stood well; and, although showing the cavities so common in these stones, have not weathered. Most of a large flour-mill at Rockview, Inisnag, is built of this creamy dolomite, from a quarry on the opposite side of the King's River.

Callan, Urlingford, Gowran, and Thomastown.—Quarries in the vicinity or neighbourhood of these different towns. Grey and blue limestones, suitable for all sort of cut-stone purposes.

Bonnetrath, Black Quarry, St. Kyran's, Templemartin, Archer's Grove, Sion House.—These quarries are all in the neighbourhood of Kilkenny, and give stones more or less favourable for cut-stone purposes. The Black Quarry and that at Sion House (now filled in) were quarried principally for the marble beds (see *Marbles*).

Ballykilaboy, Ballykeaghan, and Granny.—These quarries are situated in the south of the county, near Kilmacow and the River Suir; they are principally worked to supply stones to the counties Waterford and Wexford. Grey, crystalline, fine to coarse-grained; easily worked; take a good polish. The best stone can be procured at the first and second localities, and of large sizes—17 feet by 4 and 6 wide, and 2 feet thick. They have been extensively used in Waterford, as has also been the Granny stone, which, as it is situated on the bank of the Suir, and can be cheaply brought to Waterford by water, is utilized, notwithstanding its being of a flaggy nature and friable.

The lime made in this county is, in general, very good.

KING'S COUNTY.

Except in Slieve Bloom and in Croghan Hill, the rocks of this county are limestones, some being of excellent quality and well known.

Banagher.—In this vicinity the rocks are of the Calp type. Dark-blue or grey, inclined to black, earthy, in part flaggy, and difficult to dress; can be raised in large blocks suitable for coarse work, and were used extensively in the works for the improvement of the Shannon navigation; also in the buildings in the town and neighbourhood.

Skerough.—A mile from Birr or Parsonstown. Grey; compact, semi-crystalline; uniform in colour; easily worked; has been used very much in the public buildings of Parsonstown.

Clonmacnoise (Seven Churches).—Grey; thin-bedded; some beds very fossiliferous; weathers unevenly. Stones of large size, but modern thickness, can be obtained. This stone was very much used in the old buildings at Clonmacnoise, and in the works on the Shannon. The fossiliferous beds full of encrinite stems (locally called "screws") when polished have a quaint appearance, and have been much used for chimney-pieces, &c., having been formerly very extensively wrought at the Killaloe marble works. Wilkin-son remarks, in connexion with the ruins at Clonmacnoise:—"In the doorway of one of these churches this stone has been used for delicate carving, and the surface of the door-jambs is polished, doubtless to display what was considered a beautiful material."

Upper Eglish.—Eighteen miles from Parsonstown. Grey, compact, easily worked. A great deal is sent to Parsonstown, being cheaper than the stone in that neighbourhood.

Killane.—Near Edenderry. Grey, compact, easy to work.

Ballydule (Tullamore).—Grey, with purplish tinge, crystalline, massive, thick-bedded, and can be obtained in large blocks. It takes a fine polish, and is then of a dove-colour, clouded with a darker tint. It is very much admired in chimney-pieces and ornamental slabs. This well-known and beautiful stone has been used in the tracery, windows, and dressing, in St. Patrick's Cathedral, Dublin; for columns and cornices of the Club-house, Kildare-street; the Roman Catholic Church, Monasterevan; and in numerous other places. Formerly more used in Dublin than

at present, the Ballinasloe stone having, in a great measure, taken its place. This seems to be due to the cheaper carriage of the latter stone.

Lime, in general, is very good and cheap in the King's County.

LEITRIM.

Although a large portion of this area is limestone, yet this being, in general, of a calpy character, the best cut-stones are usually brought from the neighbouring counties. The caps on the gate-posts of the King's Demesne, near Drumsna, came from Ballinrobe, in the Co. Mayo. In the north portion of the county there are in some places very good stones, but no quarry of more than local note seems to be worked.

Mealwood.—Three miles and a-half from Carrick-on-Shannon. Greyish-blue; crystalline; compact; splinty; difficult to work: large blocks can be procured. Formerly this stone was much used, but of late better stone is brought from Hughes' Wood, in the Co. Roscommon.

Castlesavin. Three miles from Carrick-on-Shannon.—Whitish-grey, crystalline; fairly easy to work; retains its colour.

Ballinamoe.—The stone here similar to that at Mealwood.

Kilbride.—One mile from Drumsna. Bluish-grey; not very good for tool-work.

Lime in this county good; of superior quality near Manor-hamilton.

LIMERICK.

More than half of this county is occupied by limestones of different qualities, the rocks being more distinctly and regularly grouped than elsewhere in Ireland, as previously pointed out (page 375). Margining the exposure of sandstone is the dark-blue, coarse, grey bedded Lower limestone, having over it the unbedded *Fenestella* limestone, and above that the Calp, ranging from a coarse slate and shale to marble; and above all, under the Coal-measure shales, the Burren-type rock.

Corrig. A little S.S.E. of Foynes.—Dark-blue and grey, crystalline; in part earthy; works fairly well; flat-bedded; capable of being raised in very large blocks. Used extensively in pier-work on the Shannon, both in Clare and Limerick.

Aakeaton.—The Fenestella limestones of this neighbourhood were used extensively in the old castle of the Geraldines, and in Aakeaton Abbey. The beauty of the stone, its qualifications for cut-stone purposes, and its durability, are displayed in the ornamentation of the banqueting-hall of the castle and the windows of the abbey, but especially in the pillars of the cloisters. The latter are beautiful examples of carving, while at the same time they exemplify the fact that this stone is capable of taking a good and lasting polish. The exact place where these stones were quarried is not known; they are speckled greys, with tints of pink and dove-colour.

Kylethane (near Rathkeale).—Dark calpstone, inclined to blackish; in part shaley; hard, but works evenly except across the grain.

Churchtown (Newcastle West).—Dark grey. Works freely, but is very wasteful.

Drumroe.—Seven miles from Newcastle. A somewhat similar stone, but better than that at Churchtown, and generally preferred to it, but it is very brittle.

Ballycummin.—About three miles from Limerick. Bluish-grey; works well.

Rosbrien.—Near Limerick. Very similar to last; a good stone.

Limerick.—*Thomond Gate*.—Greyish-black; fine, and close-grained; some of the beds formerly worked for marble of a superior quality. *Bridge quarry*.—Grey; compact; a good sound stone. *Carey's-road*.—Dark grey; semi-compact. *Gilloge*.—Blackish; very close-grained; good hydraulic lime. *Railway Quarry*.—Grey, black, and green. The black stone was worked for marble many years ago, and was good, being sent to the London market; the green is tuffose and arenaceous; works easily; friable; not durable; used extensively in the new railway station. The grey stones and those in the other quarries work more or less freely and well. They have been extensively used in Limerick and the neighbourhood.

Charleville.—Dark-grey; crystalline; compact; a free-working stone.

Quarry Hill, Knockany.—Four miles from Kilmallock. Greyish-blue; close-grained; very easy to work. It would appear from the nature of the stone that it was from these quarries that

the stones were procured to build the Abbey, and the Geraldine town of Kilmallock. In the latter, a few years ago, there were excellent examples of this ancient cut-stone work; but during the last twenty-five years nearly all these old structures have been removed.

The lime in this county, in general, is good; but that made from the Churchtown stone (Newcastle West) is poor in strength, and slacks slowly: the lime made from the Calp, near Rathkeale and Adair, is also poor.

At Robertstown, between Barrigone and Foynes, there is a stone that gives a good hydraulic lime, which was used at Askeaton Mills. In Gilloge Loch quarry, two and a-half miles north-east of Limerick, there is a good hydraulic limestone, which was used extensively during the building of the new dock at Limerick.

LONDONDERRY.

This county is another of those in which there is very little Carboniferous limestone; it only being found in a tract between Maghera and Magherafelt. It is principally quarried for lime-burning, some of it being hydraulic.

Along the margin of the dolerite plateau, White Limestone appears in places, and is rather largely quarried, but principally for lime-burning, as its brittleness and jointy character make it yield unequally to the hammer, and unfit for fine tool-work. It can, however, be scabbled into blocks of small dimensions, which can be used in rough masonry.

In the hill-country, especially south and south-west of Dungan, there are many beds of metamorphic limestone (Ordovician?) quarried principally for lime-burning.

The principal quarry in the Cretaceous rocks is at—

Spring Hill (Moneymore).—White; very pure; hard; fissured and cracked. Cannot be raised in large sound blocks. Can be scabbled into blocks of small size. Extensively used in Moneymore when building the principal houses.

The quarries in the Carboniferous limestone are as follows:—

Desert Martin.—Bluish and brownish; rubbly; some beds yellowish-grey; solid; finely granular; crystalline, magnesian, and hydraulic. Used almost entirely for lime-burning.

Drumbally.—Very similar to the limestone at Desertmartin, and, as there, the yellowish rocks are hydraulic.

The limestones from the metamorphic rocks in the Tirkeeran Hills (south and south-west of Dungiven) give a good, strong, dark-coloured lime; while those of Carboniferous and Cretaceous age give purer and clearer products, and also yield a larger return.

At Desert Martin and Drumbally there are good hydraulic limestones, which were extensively used during the building of the bridges over the Bann, at Coleraine, Portglenone, and Toome.

LONGFORD.

Except to the northward, where the older rocks are exposed, this county is principally Carboniferous rocks. They, however, are nearly invariably more or less obscured by surface accumulations, such as drift and bog.

Lisryan. Four miles from Granard.—Dark-grey, earthy, compact; pyritous in places; principally in layers; partly shaly.

Crossrea. Near Granard.—Dark-grey; spotted when polished; coarse; in part fossiliferous.

Creeva. Three miles from Longford.—Light-grey. In the upper portion the beds are from 2½ inches to 3 feet thick, but the lowest bed is over 18 feet thick. From the 2½-inch bed flags 30 feet square or more could be procured. From the bottom, blocks 10 feet long and 6 feet wide can be raised. The stone is very highly thought of, and was used in the building of Carrickglass House.

Richmond Harbour. Five miles from Longford.—Greyish-blue; can be raised in very large blocks. Used extensively in the Shannon works at Tarmonbarry.

Itathcline. Near Lanesborough.—Dark-grey; compact; works freely and polishes well. It was used largely in the works on the Shannon in the vicinity of Lanesborough.

The lime of this county is generally good.

LOUTH.

A very small extent of Carboniferous limestone is found. It occurs in the valley of the Boyne, at Ardee, north and north-east of Dundalk, and near Carlingford.

Greenore and Carlingford.—Bluish-grey. Extensively quarried

to supply the south portion of the Co. Down and Dundalk with lime and cut stone. In some beds very large blocks can be raised; principally quarried for lime; not very good for tool-work.

Kilcurly. Two miles from Dundalk.—Greyish-blue; compact; crystalline; works freely.

Ardce.—Dark-grey; semi-compact; difficult to work.

Drogheda.—Dark greyish-blue, inclined to black; earthy; compact; in part shaly. The old buildings in which it has been used are very much weathered.

Sheephill. Three miles from Drogheda.—Light bluish-grey; crystalline; compact; works freely. A good stone, very unlike any other in the county, being more like those at Lough Sheelin, in the Co. Meath (Ross Castle). It has been used in some of the public buildings in Drogheda, and extensively in the adjoining portion of the Co. Meath, and in the restoration by Mr. Roe of Christ Church Cathedral, Dublin.

Lime strong and good, but dark-coloured.

MAYO.

As in the adjoining county of Galway, there are here also extensive crags or sheets of bare limestone, especially in the neighbourhood of Lough Mask; and the good quality of the limestone has prevented other stone being wrought or even looked for.

Cong and Bullinrobe.—In various places in the neighbourhood of these towns, varieties of grey and blue; crystalline; compact; sound; works easily; splits easily; can be raised in very large blocks; suitable for all kinds of cut-stone purposes.

Westport.—Two quarries in the vicinity, the larger called *Farm Quarry*. Greyish-blue; very good quality; bedded from $1\frac{1}{2}$ to 2 feet thick. At the Farm Quarry there is a clearing of about 20 feet of soil and 16 feet of bluish sandstone. A peculiarity of the limestone is the occurrence of invisible joints, called "threads" by the quarrymen. These do not detract from the value of the stone, as it does not weather, nor, when in work, do the stones crack along them. They are of great use to the workmen, as by experience they have learned that, if they throw water on the face of a bed, they can see the "threads" when it is drying off, and subsequently, by the judicious application of the wedge, they can readily split the stones.

Wakefield, or Black Quarry (Castlebar).—Dark-grey or blackish, of the Calp type; very coarse; can be scabbled, but not fine-worked; very large blocks can be raised.

Moneen. One mile from Castlebar.—Bluish-grey; fairly easy to work; was used when building the gaol and infantry barracks.

Crossmolina.—Dark-grey to blackish; compact; dense; earthy. It is quarried near Rosserk Abbey, which was partly built of it. Wilkinson points out that it is not a stone to be recommended, as it is brittle, and liable to break off when in work, which, he points out, can be seen in the windows and doorways of the Fitzgibbons' Castle, a few miles north of Castlebar, where a similar stone was used.

Ballina.—In this neighbourhood the stone is very similar to that of Crossmolina.

Moyne. Seven miles from Ballina.—Dull-grey; has an irregular fracture, but can be worked in any direction, and can be procured in very large blocks. A superior stone for any cut-stone purposes. It occupies a considerable area between Rosserk and Killala, the latter town being built on it; it also occurs at Moyne Abbey. The durability of the stone and its excellent qualities are exhibited in the Round Tower of Killala, the Abbey of Moyne, and the cut-stone in Rosserk Abbey. This stone was also used in the mansion of the Knox-Gores, near Ballina, and for cut-stone in the Roman Catholic cathedral.

Excellent lime is made from the Carboniferous limestone; also from boulders in the Drift. A Silurian limestone near Toormakeady is said to be hydraulic. Near Cong there is a clay which, if mixed with lime, makes it hydraulic; used extensively at Cong in the river works, and at Lord Ardilaun's fountain.

MEATH.

Carboniferous limestone occupies the principal part of the county, but it is divided into north and south districts by a tract of arenaceous and slate rocks. The stones in the southern district partake very much of the Calpy nature of the rocks in the Co. Dublin, while very superior stones are procured in the northern division, the quarries of Ardbreccan and Rosscastle, or Cashel, being extensively known; also the neighbouring quarry of Crossagh.

Ardbreccan. Three miles from Navan.—Brownish-grey; when dressed, grey, very crystalline; works very freely; can be obtained of very large sizes: a very superior working-stone. Has been extensively used at Navan, Trim, Kells, Slane, and elsewhere—even at great distances.

Crossdrum.—Two miles west of Oldcastle. Whitish-grey; very pure; works freely. Can be obtained in blocks of large sizes.

Rosscastle or Cashel.—Seven miles from Oldcastle, close to Lough Sheelin and the mearing of the county; a very superior stone and in much request. It is like the Crossdrum stone, but of a finer texture and lighter colour; is extensively used in this county and in Cavan and Longford, the columns in the Roman Catholic church of the latter having been procured there. It was also used in the building of Loughcrew House.

Crossagh, near Rosscastle.—The stone is very similar, but coarse: yet it is more preferred by the builders in Dublin.

Trim.—Dark-blue to blackish; of the Calpy type; earthy, but compact; even-bedded; a good workable stone for plain building, but will not dress well. Has been used in most of the public buildings in Trim, also in the old Norman castle and ecclesiastical structures; but in the latter sandstone has been employed where cut stone was required.

Drogheda.—Near Drogheda the stone is, in general, grey and brittle; but to the eastward it is dark-grey to blackish; of a Calpy nature, and can be raised in very large blocks suitable for rough work. Large quarries were opened at the east margin of the town, from which were procured the stones to build the Boyne Viaduct; the dressing and cut-stone work being brought principally from Ardbreccan or Milverton, near Skerries, Co. Dublin. Farther eastward, adjoining the river flats, there are the Corporation quarries, from which were procured the stones for the extensive harbour improvements.

Lime very good; made from the Carboniferous limestone and from the boulders in the drift.

MONAGHAN.

The limestone is of Carboniferous age, and is generally of a Calpy nature, not suitable for tool-work. Some of the best stones in the

neighbourhood of Clones and Monaghan are situated in such low ground that they are liable to be flooded, and are, therefore, too expensive to work. The best quarries suitable for cut-stone purposes are in the neighbourhood of Carrickmacross.

Barley Hill. Five miles from Carrickmacross.—Dark bluish-grey; hard; well suited for tool-work, but rather difficult to work. Lime good, but often dark-coloured.

QUEEN'S COUNTY.

Carboniferous limestones occupy the central portion of this county. In some places the stone is of very good quality, but in others it is inferior, being of a Calpy type.

Stradbally.—Light brownish-grey to grey; close-grained; well suited for cut-stone purposes. Has been largely used in this and the neighbouring county of Kildare. In all the public buildings at Maryborough it has been used; also at Monasterevan and elsewhere.

Dunamase. Two miles from Stradbally.—Grey; compact; slightly splintery; but otherwise a good stone.

Spire Hill.—Five miles from Mountmellick. Grey; oolitic; slightly silicious; does not work freely.

Thornbury (Abbeyleix).—Dark greyish-blue; silicious, and difficult to work.

Bailgullen. One mile from Abbeyleix.—Greyish-blue. This is kinder and more easily worked than the Thornbury stone, and is more generally used in Abbeyleix.

Portarlinton.—Good stone for rough work; quarried in different places, but not approved of for tool-work.

Graigie. On the edge of the county, a suburb of Carlow.—The quarries here were principally worked for marble. The associated stones being burnt for lime.

Lime very good, cheap, and abundant.

ROSCOMMON.

Nearly the whole of this county is occupied by Carboniferous limestone, only some very subordinate tracts of older rocks appearing up through it. The rocks are very varied in character, from bad Calpy stones to those of the Burren type. There are, however,

dispersed over the county, many quarries capable of producing a good class of stone.

Crisnagh. Near Boyle.—Grey; semi-compact; crystalline; works well and freely.

French Park. Near Boyle.—Grey; close, and compact; a free-stone; works well. The quality of the stone near Boyle, and its suitability for tool work, were not formerly recognised. When Rockingham House was built, the stones were brought sixteen miles from Ballinafad, Co. Sligo. Some of these stones polish well, and are used for tombstones.

Hughestown. A few miles from Carrick, near the Shannon.—Light greyish-blue; some of a better class become of a lighter colour when worked. This stone has been used in Carrick-on-Shannon in preference to the stone at Mealwood.

Castlereagh.—Between this town and Boyle there are different quarries; but the stone is more or less of a Calpy nature, and difficult to work. Mount Sandford House, near Castlereagh, was built of stone brought from Bellanagore, about nine miles distant.

Bellanagore. Seven miles from Elphin, the quarries being situated a few miles to the west and south-west of the village.—Dark to light grey; much freer than the stones near Castlereagh; but inferior to those near Boyle.

Aughris. About two miles from Roscommon.—Dark to light grey; fine; crystalline; works freely.

Scardaun. About four miles from Roscommon.—Dark to light grey; works freely; in character very like those of the barony of Burren, Co. Clare.

Lecarrow (Knockcroghery).—Grey; finely crystalline; regularly bedded; in parts cherty; works fairly well.

Tughmacconnell.—In this stony district the rocks are of types similar to those in the barony of Burren, Co. Clare. Good stones might be procured, but no quarry of note has been worked, as the stones needed in the neighbouring towns of Athlone and Ballinasloe are more easily procured at the latter, in the Co. Galway, and at Clonmacnoise, in the King's County.

The lime in this county is excellent and cheap.

SLIGO.

In this county, as in Mayo and Galway, there are extensive crags and cliffs of Carboniferous limestone. The rock, however, is not, in general, as good a class of stone; those about Lough Arrow, to the south, and some beds near Ballysodare, being considered of the best quality. Many of the Sligo stones are more or less of a Calpy type, and difficult to dress; yet in the old abbey at Sligo the local blackish stone was used for all purposes; and in the ruins are different examples of excellent work still in good preservation; but of late years the Killea sandstone, Co. Leitrim, seems to have been preferred for cut-stone purposes.

Ballysodare.—Greyish-blue; crystalline; semi-compact; easily worked; takes a good polish; has been used for tombstones.

Ballinafad. On the south-west shore of Lough Arrow.—In different places, grey and blue; crystalline; semi-compact; easily worked. Formerly much used before the quarries at Boyle, Co. Roscommon, were opened; the stones for Rockingham House, near Boyle, having been brought from this neighbourhood.

Lime of the county good and cheap, but often dark-coloured.

TIPPERARY.

Except in portions of the barony of Lower Ormond, where it is of the Calp type, the limestone of this county is of a very uniform blue colour, and compact. It has been very generally used in some of the best ancient ecclesiastical structures. On this subject Wilkinson writes:—"At Cashel, with the exception of the sandstone used in the construction of Cormac's Chapel and the Round Tower, limestone is the material with which all the buildings have been erected. At Holycross this stone has been used; and the beautiful ruins in both these places show the excellent quality of the stone, both as regards the fine work it is capable of receiving, and its durability; for the mouldings of the oldest parts are still fresh and sharp on the edges, and even preserve the marks of the tools used in preparing them."

Fir Quarry, Ballinderry. Not far from Carrick-on-Suir.—Grey; close; even-grained; difficult to work.

Camus. A short distance from Cashel.—Light-grey; easy to work.

Lewagh (Holycross). A little north of Thurles.—Dark-grey; semi-compact; a very superior stone for all fine work. This appears to have been the stone with which Holycross Abbey was built.

Castle Meadow. One mile from Thurles.—Grey; free working; very good for dressed work.

Ballinacurra. Four miles from Clonmel.—Dark greyish-blue; coarse and earthy beds; rather difficult to work, and more suitable for rubble than dressed work.

Lisbunny. Near Nenagh.—Dark-blue, compact; earthy; in general not difficult to work. Some beds are more argillaceous than calcareous.

Loughalton. Two miles from Nenagh.—Dark-blue to blackish; some beds lighter, and greyish; works easily.

Loughorne. Three miles from Nenagh.—Variable in colour; shades of light-grey, dark-grey, and blue; in general compact; the blue stones very earthy; works easily.

Ballinillard. Near Tipperary.—Greyish-blue. A light-coloured magnesian limestone lies below the blue; works well.

Portland.—Near to Portumna Bridge. Dark-blue to blackish; earthy; in part shaly; large blocks can be raised. Used extensively in the works on the Shannon. In this portion of the barony of Lower Ormond the rocks are of the Calp type, and are not in general suited for cut-stone purposes.

In general very good lime; some dark-coloured. Some of the Calp beds either will not burn, or will do so with difficulty.

TYRONE.

In this county are found Cretaceous, Carboniferous, and Metamorphic limestones. The White Limestone (Cretaceous) occurs to the north-east, near Coagh and Stewartstown; the Carboniferous occupies more or less scattered and semi-detached tracts; while the older limestones are found in bedded masses among the metamorphosed rocks of Ordovician and Cambrian (?) ages in the north-west of the county. Dolomite, containing Permian fossils like those at Cultra, Belfast Lough, Co. Down, has been found at Tullyconnel, near Ardtrea, a mile to the west of this place; and in sinking a coal-pit at Templereagh, adjoining the Aunaghone colliery.

These Permian rocks have not been utilized. The Cretaceous are used principally for lime-burning, and so are also the Metamorphose limestones, and in a great measure the Carboniferous. Limestone is not, in general, used for cut-stone purposes, as sandstones of excellent qualities occur in different places, and they are usually preferred.

Cookstown. At Railway Station.—Various shades of grey to pink and red; fossiliferous; crystalline; some beds compact, and take a good polish. In beds from an inch to 4 feet thick. A little east of the town is a limestone of a purplish-grey colour; compact; crystalline; works fairly.

Broomhill. A mile north of New Mills.—A bed of hydraulic limestone; 12 feet thick proved by boring.

Drumreagh. Three and a-half miles north-east of Dungannon.—A thick bed of close-grained blue hydraulic limestone; under 37 feet of thin-bedded rock.

Keeran's Cross. Three miles south-east of Pomeroy.—A thin bed of light-brown hydraulic limestone.

Castlecaulfield.—Three miles west of Dungannon. Grey; compact; crystalline; in places flaggy, or with shaly partings between the beds; works fairly well.

The Carboniferous limestone, in general, is impure and hard to burn, or gives a dark-coloured lime; but at Cookstown an excellent white lime is produced.

The White Limestone in general gives a rich lime.

In the granite to the north-west of Pomeroy, at Limelhill, there is a peculiar compact white limestone burned for lime, but not of a good quality.

Hydraulic limestones, as above mentioned, are found at Broomhill, Drumreagh, and Keeran's Cross.

WATERFORD.

The Carboniferous limestone occurs nearly altogether in long east and west basins—one in the Youghal valley, and another in that of Dungannon, with a small tract in the valley of the Suir. The limestone used in this county for dressed-stone purposes is principally brought from the south portion of the county of Kilkenny, being procured in the quarries in the neighbourhood of Kilmacow.

Whitechurch. South of Capoquin.—Light-grey ; hard ; difficult to dress ; has been used in the town of Dungarvan, five miles distant ; also in the railway and other bridges.

Shandon (Dungarvan).—Dark-grey ; not good for dressed-work ; much inferior to that of Whitechurch, but more easily dressed ; used in building the Courthouse ; gives superior lime.

Oughboy.—A mile from Lismore. Light-grey ; hard, but brittle ; coarse ; easy to work.

Between Lismore and Dungarvan there are in places small quarries, where fair stone for tool-work has been procured. Some beds take a good polish, and have been used as marbles.

Dunkitt.—Here, and also on the north side of the Suir (Co. Kilkenny), limestone has been extensively quarried, to be sent down the Suir and up and down the Barrow, to supply the counties of Wexford, Kilkenny, and eastern Waterford, with stones for lime-burning. It is a thin-bedded, shaly, earthy stone ; but as it can be cheaply carried by water to Waterford, it has been very extensively, though not always advantageously, used there.

Good lime, but dark-coloured in general.

WESTMEATH.

Except in a few isolated places, Carboniferous limestones occupy the whole of this area. The rock is, however, comparatively speaking, seldom seen ; and when it comes near the surface it is usually of the Calp type ; or of a character unsuitable for cut-stone material. For this purpose limestone is principally obtained from Clonmacnoise, King's Co., and Ballinasloe, Co. Galway, and formerly from Rosscastle, Co. Meath. A good stone, also used as a marble, occurs near Moate, while others have been extensively quarried about Mullingar, and used in that town : the stones, however, near Mullingar do not give fine or durable work.

Hall. Three miles south-west of Moate.—Grey, with splashes of white and red : of good quality, worked as a marble ; extensively used in the new Exchange, Manchester, and in other places in England.

Bunbrosna and *Multyfarnham.*—Dark-blue to blackish ; even-bedded. Various quarries, at which the stones are principally raised for rubble work and flagging.

Pakenham Hall. A mile from Coole.—Dark-grey; crystalline; fossiliferous; earthy; a fair stone.

Kerry. Three miles from Mullingar.—Dark-grey to blackish; compact; earthy; in part shaly; works freely; used in the Catholic Church, Mullingar.

Fulmore.—Seven miles from Mullingar. Dark-grey to blackish; Calp type. Large stones can be raised, which were used in the Railway Works and Mullingar.

Lime good, but dark-coloured. Hydraulic limestone occurs at Donore, where other beds give a very good lime.

WEXFORD.

In this county there is very little Carboniferous limestone, as it only occurs near Wexford, in a strip running south-west from the south of the harbour to the sea, near Duncormick, and in the promontory of the Hook. It is not much used for building purposes, although formerly much quarried for lime-burning. It is more or less of the Calp type, and not well suited for cut-stone purposes. Large blocks can be raised, and the stone from the Drinagh quarries, south of Wexford, were used in the construction of the new pier at Ballygeery in the South Bay. The quays also, and other buildings, have been built from similar stones, procured here or in the quarries in the neighbourhood. The limestone at Drinagh is in part hydraulic.

In the Ordovician rocks there are beds of limestone and calcareous tuffs. The limestones are used principally for lime-burning, especially one bed near Courtown Harbour, which is in part hydraulic. The tuffose limestones dress easily, and have been used in the railway bridges, but they do not appear to be durable.

Good strong but dark-coloured lime from the Carboniferous limestone; the Ordovician limestones also give strong dark-coloured lime, but not good returns. In old times, even at considerable distances from the coast, sea-shells were burnt into lime.

Hydraulic lime can be made from some of the beds in the Drinagh quarries, while a poorer hydraulic limestone occurs at Courtown.

WICKLOW.

This is the only county in Ireland in which Carboniferous rocks have not been found ; nor is it likely that any outlying patches occur under the superficial accumulations. It was also generally believed that no limestone of any kind exists ; but of late years this has been proved to be incorrect.

In the Glenart demesne, near Arklow, to the westward of the Castle, there is a very impure thin bed of limestone. Westward of Castlemacadam, near the church, in the brow of the hill, there are beds of flaggy limestone, which seem to have been worked to a small extent in former times ; and to the north-east this limestone again appears in the brow of the hill, west of the Ovoca railway station. A bed of limestone was cut in the Avonmore valley when driving up the level from the old Glebe to Connery mine ; while limestone also occurs near Westaston, some few miles eastward of Rathdrum. None of these limestones have, at least in late years, been quarried ; but they appear to be of a quality very similar to the Courtown limestone, Co. Wexford.

APPENDIX.

[Read, February 16, 1887.]

[The following List of some limestone quarries, used of late years in public and private works, has been procured through R. U. Roberts, Esq., Commissioner of the Board of Public Works. Each detailed description, where possible, has the name of the Officer (in brackets) after it. This List being supplementary to the foregoing Paper, for the most part only refers to quarries not therein mentioned, except in those cases where, in connexion with recent buildings, the stones have been procured from some of the well-established quarries.]

ANTRIM.

CRETACEOUS.

Drumnasol.—Drumnasol Lodge. The rock locally called *White Limestone* (indurated chalk). This rock occurs all round the coast of Antrim: it is used mainly for lime; but sometimes it is used for dressing. It is too full of joints to look well, or to stand frost (*W. Gray*).

ARMAGH.

CARBONIFEROUS.

Glasslough.—Used in the spire of Corporation-street and Carlisle Churches, Belfast; also in Robinson Villa, Cultra, Co. Down. "Of a good high colour; works freely; durable" (*W. Gray*).

CAVAN.

CARBONIFEROUS.

Rocks.—One mile from Cavan.—Surface rock; no regular quarry. Used in the Masonic Hall, Cavan (built 1885), for walling. The stone seems to be durable, and works freely. The dressings are of sandstone from Lisnaskea, Co. Fermanagh.

Ardhill.—Six miles south-east of Cavan.—School; built 1886. The local stone only used for walling and rubble; those for the dressings being procured from Crossdrum, Co. Meath.

Mount Nugent.—Drumrora School; built 1886. The stone is only suitable for walling, and is said to be durable. The dressings from Ross, Co. Meath.

CLARE.

CARBONIFEROUS.

Bushy Park.—Ennis Courthouse, in entire building; in Prison, for dressed work. Light colour; worked easily.

Rosslevin.—Ennis Prison, used with the Bushy Park stone. Dark colour.

Kilfenora.—Ennistymon Church. Dark colour; worked hard (*W. D. Williams*).

CORK.

CARBONIFEROUS.

Carriglass and Conna.—Carriglass School and Conna Glebe-house. Used for the rubble-work and quoins; but it is of too small dimensions for the sills of windows and doors (*A. T. Williams*).

Ballydaniel or Pothouse.—Ballydaniel Schoolhouse and Residence solely built of these stones. The stone has also been largely used for heavy railway works, but is not suitable for sills, or in general for ordinary building purposes (*A. T. Williams*).

Cloyne.—School. The local stone runs in small sizes; and for large scantlings the Carrickacrump stone is used.

Carrickacrump.—For the description of this well-known stone, see page 416. Mr. Williams points out that it has been extensively used in the Cork harbour and Haulbowline works.

Ballintemple.—School. This stone is another that is well-known, having been made historical by Macaulay (page 168).

Ballintubber (Kanturk).—Used in the dressings for the Church, Killarney, Co. Kerry. Light-coloured; a very superior stone.

Mitchelstown.—Between the town and the workhouse. A marble; grey; a good working stone (*J. Newstead*).

Boreenmanagh and *Haulbowline Island*, near Cork.—Reddish; slaty character; formerly used to some extent for chimney-pieces. About one mile south-west of Cork there is a vein about three or four inches thick in the ordinary limestone.

Ballyclough, near Mallow.—Reddish; hard; slaty character; suitable for flagging; formerly used a little for chimney-pieces.

DONEGAL.

METAMORPHIC CAMBRIAN? OR ARENIG?

Dunlewey.—A marble, used in Dunlewey Church for dressing, walling, and rubble. In Glenalla Church, near Rathmullen, for dressed work in the windows, doors, and buttresses. Capable of good and fine work; a superior stone, but cannot be raised in large sizes.

Ballymon.—Sheephaven Coastguard Station. An inferior marble, used in the quoins, piers, and sills; very hard to work; very durable (*J. Cockburn*.)

Glenree ("Cooskeagh Quarry"). South-west of Carrigart.—Whitish, grey-clouded, and greyish. A marble. Free and kind; durable; a good stone for inside and outside work. Used for the dressing of the Millford Union Workhouse; dressing buttresses and pulpit Glenalla Church; chimney-pieces Glenalla House; inside work Carrigart Roman Catholic Church. The fonts at Ramelton and Glenalla Churches were cut out of one block (*J. M'Fadden*).

Barnes Lower (O'Donell's Quarry). North-west of Kilmacrenan.—Greyish-blue; durable; a good stone for hammered, dressed, and rubble work. Quarry opened in 1846, when building Kilmacrenan New Church; since has only been worked for lime-burning (*J. M'Fadden*).

Carn Lower. North-east of Rathmelton.—Limestone; hydraulic.

[In this county, more than any other in Ireland, are the metamorphous limestones capable of being used for cut-stone purposes. See p. 169.]

CARBONIFEROUS.

Ballyshannon (various places in vicinity).—Convent of Mercy, Ballyshannon. Hand-punched for facing and quoins; it works

freely and well. Also for internal work, with sandstone, in the Belfast Banking Co. Buildings (*J. Cockburn*).

DUBLIN.

CARBONIFEROUS.

Milverton (Skerries).—Balbriggan Coastguard Station. Used on the base of the octagon tower, sills, and dressings; also in Rockabill Lighthouse. A hard limestone, rather stiff to work (*see* description, p. 172).

Howth.—Grey; magnesian; makes good *hydraulic lime*.

GALWAY.

CARBONIFEROUS.

Angliham.—Queen's College; Model School; Parapet of the Tower of St. Nicholas' Church, all in town of Galway. Used for the sills, quoins, and dressings; works freely, and found durable.

[In this neighbourhood (*Angliham*), as previously mentioned (p. 177), there are acres of most superior stone. As these lie in nearly horizontal beds, they ought to be invaluable, if worked on the American principle of cutting them by machinery *in situ* in the quarries. An enterprising Company might "run a big thing in stones" from the Port of Galway for the English market, more especially as the freights from all the west coast of Ireland are low, most vessels having to leave it in ballast.]

KERRY.

CARBONIFEROUS.

Lixnaw.—Dominican Church, Tralee. A marble, close-grained, uniform texture, and capable of a high polish. Used for the moulded bases and the columns of nave.

Ballylaggan (near Tralee).—St. John's Church, Tralee. Used for the dressing in the new addition. Light-coloured, superior stone; free, durable; works out in large blocks.

Castleisland.—Roman Catholic Church. A marble capable of a high polish. Colour, light red. Used in the piers of the chancel.

KILKENNY.

CARBONIFEROUS.

Kilkenny (vicinity of).—Used in the Kilkenny Model School, Lunatic Asylum, Agricultural Museum, and other public buildings,

for punched, chiselled, or moulded work. The stone is of a good grey colour; hard and durable; it flies well before the punch and chisels to a good surface, but not so fine as that of the Ardbreccan stone, or of that of Sheephouse, Co. Meath (*M. Mellon*).

Ballykilboy and Strangs Mills.—Waterford City, in the Government offices and public buildings. Granite and limestone dressings in both buildings worked freely (*W. D. Williams*).

LEITRIM.

CARBONIFEROUS.

Carrick Klevy Station.—Carrick-on-Shannon Roman Catholic Church. Durable; squares well under the hammer. For chiselled work the stones were brought from Lanesborough and Creeve, Co. Longford.

LONGFORD.

CARBONIFEROUS.

Creeve. Near Longford.—Used for dressings in the Roman Catholic Church, Carrick-on-Shannon; in the Bishop's Palace, and in the Asylum, Mullingar; in the Crummy School, half-way between Carrick and Ballinamore, Co. Leitrim; and in Cloonmorris School, between Dromod and Newtown Forbes.

Lanesborough.—For dressings used in the Ballymahon School; in the Roman Catholic Church, Carrick-on-Shannon; and in the new Convent, Sligo.

Ballymahon.—Very brittle; hard; difficult to work; durable. Used for rubble in the National School.

MAYO.

CARBONIFEROUS.

Moyne (Ballina).—Used for dressing and walling in the Roman Catholic Cathedral, Ballina, and in various buildings, both modern and ancient, as given in the descriptions of the Mayo quarries. "Works freely; found durable; but weathers of a bad colour" (*R. Cockrane*).

MEATH.**CARBONIFEROUS.**

Ballymadrin. Three miles from Ratoath.—Is fairly good and durable. Used in the walling of Ratoath Dispensary; built in 1886. The stones for the dressing procured from Crossdrum.

Stirrupstown. Near Crosskeys.—Hard, and only fit for scabbled work. Used for walling in the neighbouring Constabulary Barrack. The stones for the dressings were procured from Crossdrum.

Ross.—This well-known stone is very generally used for cut-stone purposes in various parts of Ireland (*see* description, p. 188).

Crossdrum.—Another well-known stone (*see* description, p. 188).

QUEEN'S CO.**CARBONIFEROUS.**

Stradbally and Ballullen.—Maryborough Churches, Prison, and Asylum; Mountmellick Churches and Convent. In Abbeylex Churches, with Slieve Bloom sandstone; both being used in the dressings (*W. D. Williams*).

ROSCOMMON.**CARBONIFEROUS.**

Carrowroe. Two miles from Roscommon.—Works pretty freely; is durable. Used for walling and rubble in the new Convent, Roscommon. The stones for the cut-work were procured from Lanesborough, Co. Longford.

SLIGO.**CARBONIFEROUS.**

Ballysodare.—A uniform stone; works well into mullions and tracery, and is durable. Used in St. John's Church, Sligo, in the new east window, vestry-room, and organ-chamber (*R. Cochrane*), and in the Roman Catholic Church and Presbytery for both dressed work and rubble.

Scarden. Three miles from Sligo.—Hard and flinty; durable. Used for rubble and the pitched faces of the walls in the Town Hall, Sligo. The dressings are of sandstone, from Mount Charles, Co. Donegal.

Carrowroe. Two miles from Sligo.—Works pretty freely; is durable. Used for walling and rubble in the new Convent, Sligo; the stones for the dressing being procured from Lanesborough, Co. Longford.

[In the hills to the north-east of this county there ought to be excellent limestone for all dressed purposes; as, however, there are no quarries opened, they send to great distances for stones for dressings and other cut works.]

TIPPERARY.

CARBONIFEROUS.

Ballinillard.—Churches, Tipperary Town. Appears to have worked freely.

TYRONE.

CARBONIFEROUS.

Omagh. Vicinity.—Used for rubble in the Military Barracks. The sandstone used for quoins and dressing is of an inferior quality, being the stone known as the “Red Beds” from the Gortnaglush quarry, near Duncannon, which is easily worked, but is not durable (*J. Cockburn*).

WATERFORD.

CARBONIFEROUS.

Whitechurch.—As dressings in the Churches, Dungarvan; and Lismore Castle.

Shorough.—Lismore Roman Catholic Church, with sandstone dressings (*W. D. Williams*).

WESTMEATH.**CARBONIFEROUS.**

Cullion. Two miles from Mullingar. — Rather hard and splintery for chiselled work ; very durable. Used in the Bishop's Palace, and in the Asylum, Mullingar, for walling, rubble, and part of the dressed work ; but in both buildings most of the stones for cut purposes were procured either from Creeve (*Co. Longford*), or Ross (*Co. Meath*).

III.—IRISH ARENACEOUS ROCKS—SANDS, SANDSTONES, GRITS, CONGLOMERATES, QUARTZ-ROCKS, AND QUARTZITES. BY G. H. KINAHAN, M. R. I. A., ETC.

[Read, March 23, 1887.]

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INTRODUCTION.

A STUDY of the history of the Irish sandstone rocks is interesting, they seemingly having been the favourites with the early builders. The primitive inhabitants of the country appear nearly invariably to have utilized the hardest stone nearest at hand, so that in many places they used the granite erratics; but in such places where there were both granite and sandstone erratics, they seem to have chosen the latter; while, if the rock had to be quarried, it was nearly always the sandstone that was selected.

After stone with mortar was introduced, at first sandstone still seems to have had the preference in the districts in which it occurred, except in a few places where there were good slate-rocks; as these, in certain localities, were extensively used, and are still used, for architectural purposes. This, however, will be more particularly mentioned in a subsequent paper on *Slates and Clays*. It may, however, be here mentioned that some of these slate-rocks, although producing good and durable work, were not at the same time capable of giving the fine and embellished cut-work to be found in the granite, limestone, and sandstone structures.

Later on, as has been pointed out by Kane, Wilkinson, and others, the sandstone was superseded by limestone, the latter rock having been often carried for great distances into the sandstone areas. This probably was due in a great measure to the workmen, who had a preference for the stone to which they were accustomed. Various examples in modern time in support of such a supposition are on record. When the Scotch workmen were building Muckross Abbey, Killarney, about forty years ago, they ignored the excellent limestone of the neighbourhood, and imported sandstone from Chester, that being the nearest place where they could get sandstone similar to that with which they were accustomed; and in different places, the engineers of the Ballast Board, when building lighthouses, have brought Dublin granite to the different localities. This may be seen, besides, in various other places, at the West Sound into Bearhaven, Co. Cork—a locality famous for its good sandstone. Kylemore Castle, Co. Galway, was contracted to be faced with granite, and although the locality

is on the edge of the great granite tract of Galway, yet the contractor elected to bring the stone from Bullock, Co. Dublin—a stone he was accustomed to. We find also the same thing in earlier times. The Normans, for dressing and other cut-stone purposes in their castles and cathedrals, brought from their native country, Caen-stone into England, while their descendants, the Anglo-Normans, did the same in regard to Ireland.

[It seems to be the general opinion that there is no home stone at present in the market equal to the Caenstone for fine inside work; but during the late restoration of Christ Church Cathedral, Dublin, some of the old cut-stones (A.D., 1008) were found, which the architect seems to have insisted were "Caenstone." But the builder (Mr. Sharpe) was not of this opinion, and, after considerable research, he was able to prove that the stone was procured in a once famous quarry at Eyebridge (P), about twelve miles from Glastonbury, Somersetshire. He visited the place, and the stones seem to have been brought from the quarries by a canal, the remains of which can be traced. From Mr. Sharpe's practical knowledge he is convinced that this stone was used in Mellifont Abbey, Co. Louth; St. Mary's Abbey, Dublin; and St. Kevin of Glendalough, Co. Wicklow—stones which in general are supposed to be Caen-stone. Mr. Woodward, the author of the *Geology of England*, in reply to inquiries, states:—"The stone you inquire about must be the Doultrey stone, east of Shepton-Mallet; used largely in the construction of Wells' Cathedral and Glastonbury Abbey.]

But the pre-Anglo-Norman builders in Ireland, as already mentioned, as also many of the early Anglo-Normans, used the native sandstone. It is conspicuous in different places, as here-after mentioned, that although the local sandstone used in building of the earlier structures was good, yet all the later structures are built of limestone brought from a greater or less distance.

Other reasons for the introduction of limestone may have been that the builders early understood the crushing stones were capable of bearing,¹ and were aware that if a column in a building was to be massive, they might use sandstone; while if the column had to be slender, and at the same time support an equal weight, limestone was preferable. This is illustrated, as pointed out by Wyley, in the small limestone columns of Jerpoint Abbey, Co. Kilkenny.

They also must early have learned that limestone could be more finely, more easily, and more cheaply worked than the

¹ Yet Wilkinson specially points out that some builders had no such knowledge, and illustrates instances in which buildings had failed through the want of knowledge as to the crushing the stone would bear.

ordinary sandstone of the country, many of the latter requiring the tools to be frequently sharpened.

Although the strength of the limestone, and the facility by which it could be worked, may have led to a preference for it, it should also be remembered, that as the country became occupied by foreigners, the chief centre of the population—that is the towns—were principally in the plains, or the valleys, on the limestone areas, and the artificers, becoming cunning in the working of limestone, preferred to use it, even when they had to transport it a considerable distance. In many places, however, they had water-carriage; that made the transport comparatively easy and cheap.

Or the use of limestone may have been due to fashion. At the present day many rich men will only use a stone his poorer neighbour cannot procure. This seems to have been a mania in remote ages as well as recently, and not without a certain value, as in many places the old buildings are pointed out as “not having in them a stone to be got in the whole country,” while in modern times Rothschild’s French Chateau has brought him historical fame on account of the English stone and workmen used in its building. Elsewhere on the Continent, in America, besides in the home countries, buildings are pointed out, not for any architectural beauty, but solely to record that the stones in them were brought from a great distance, and at great expense.

The mania for foreign stones appears to have been very prevalent in Ireland at the beginning of the present century, as in the majority of the buildings erected between 1800 and 1840 the stones for the dressed work were imported. This is very conspicuous in Dublin, as hereafter exemplified in the list of places from which the sandstone used in its principal buildings was procured.

As previously pointed out, the early builders, in most cases, seem to have selected stones on account of their durability; but at the present time there seems to be, in many cases, a running after stones—not on account of their durable qualities, but that they can be easily worked, and are therefore cheaper.

[The Ballycastle stone, Co. Antrim, if it had been well selected, everywhere gave good and durable work; yet, at the present time, in the neighbouring towns it is in disrepute, while inferior sandstones are used solely because the first-cost is less. This apparently is false economy; for although the first-cost may be less, yet the after

redressing, or painting, or otherwise doctoring of the stones induce expenses which in a short time eat up any little saving there may have been at the first in using inferior material. This can also be seen in different places in Dublin, which need not now be mentioned, as this subject will be alluded to further on.

In general, sandstone now in use, except the Caenstone, does not appear to be capable of receiving as minute work as limestone. However, if we examine the old structures, we find in some of them beautiful and elaborate work, but in such cases the stones are much harder than those now in request. The exquisite doorway of Maghera Church, Co. Derry, cut in the local stone, is so durable, that the brushing of the tools can still be seen; but this stone would not now be looked at, being considered "too hard."

According to the records, as left by our ancient buildings, it would appear that the soft and more easily worked limestone, sandstone, and granite, are best for inside work; but if the work is to be exposed to weathering, the durability depended on the quartzose nature of the stones, they ranging in the following order—quartzose sandstone, quartzose limestone, and quartzose granite. The sandstones, apparently, taking in our climate the first place.

There are, indeed, in a few places very quartzose granites and limestones of a high order, but they are exceptions to the general rule, as the majority of our best preserved old work nearly invariably is in sandstone. Outside these groups there are, however, some stones, but not very commonly met with, that show durable work, such as the Camstone, and some of the basalts.

Quartzose stones, when dry, nearly invariably are difficult to work. This is the case with the "Park stone," Wexford, which, when worked in its "quarry water," as exemplified in Roche's Churches, turns out good work. Our ancestors may have understood this peculiarity in the stones, or it is possible they may have overlooked first-costs, and speculated solely on the subsequent durability of their work—they working in hard stones that now would be condemned.

[Some sandstones which occur not uncommonly in the Carboniferous formation have a latent silicious or carbonaceous cement, and when newly raised, and in their quarry water, are soft and easily worked, but subsequently, when dry, they become as

hard as a silicious grit. Some stones contract considerably during the drying, and stones of this class, before being used, ought to be given time to dry and contract, as otherwise they will dry unevenly, and show not only unsightly open joints in the work, but are also liable to cause uneven settlements.]

The cements of the sandstones are silicious, calcareo-silicious, and argillo-silicious. Usually in a contrary order they out the more easily, while their durability is the reverse, except in some cases, that is, where they are micaceous, as many such stones, otherwise good, are not durable.

Other examples of well-preserved sandstone carving, besides the previously mentioned doorway at Maghera, Co. Derry, are exemplified in the doorway at Killeslin, Co. Carlow, cut in the local coal-measure sandstone; in the massive and beautifully carved crosses at Monasterboice, Co. Louth, the stone being a clean-grained silicious sandstone. St. John's Gate, Drogheda, in the same county, was built of mixed limestone and sandstone, and it exemplified the unequal weathering and durability, the latter being perfect, while the others have decayed considerably: it must, however, be allowed that the limestone was of a very bad class. The dressed work at Mellifont shows the durability of the sandstone. In the latter the bad effects of mica is also exemplified the micaceous sandstones that were used having sadly weathered.

[The old ruins at Mellifont, during the late repairs under the Board of Works, had the rubbish removed, and, as pointed out by Mr. Lynam, County Surveyor, the sandstones thereby re-exposed have rapidly weathered. This I have observed elsewhere, not solely in regard to sandstone—as the stones in different ruins, when exposed to the drying effect of the atmosphere, have rapidly decayed. This may be seen, as well as elsewhere, at Devenish, Lough Erne, where the re-exposed sandstones have suffered, and in St. Kevin of Glendalough, Co. Wicklow, where many of the old disinterred sculptured schist alabs have, in a few years, been greatly defaced. A cupped stone, now in "Saint Kevin's Kitchen," when first raised, had all the tool markings; but these were obliterated by its being allowed to weather for a year. It may appear remarkable that stones, when in their natural saturation, that is, having their "quarry water," harden when exposed, while stones subsequently saturated, when dried, decay. To explain this, it may be suggested that the first water, that is, the "quarry water," was in combination with either silica or carbon, the mineral matter consolidating as the water evaporated, while in the subsequent saturation, the moisture was solely water that had saturated the pores and other vacancies in the stone, thereby absorbing the cement, and when this water with the absorbed cement was withdrawn, it left the stone more or less a friable mass—at least as far in depth as the absorption had effected it.]

In Boyle Abbey, Co. Roscommon, the stone shows excellent work; it is also durable, as in places it still retains the tool markings.

[In America, and also in England, many stones, even when in the quarry, are sawn, or otherwise worked and sculptured by machinery; very little work, however, of this kind goes on in Ireland. In some workshops there is sawing and planing; but there does not seem to be a quarry in which the stones are cut *in situ*: while if a building is in progress you generally hear the hammer and chisel, and not the saw or plane, at work. However, saws, at least, were known to the early Irish builder as in many of the ancient structures the stones, especially sandstones, were sawn, not chiselled. The only instance that I can learn of saws being used to cut stone *in situ*, was in the Angliham marble quarry, Co. Galway, where, somewhere about the year 1860, Mr. Abbott erected a sawing-frame and engine; but when the block was about half out through, the saws broke off, leaving, as Mr. Sibthorpe points out, a puzzle for future geologists to explain how parallel narrow seams of oxide of iron occur in the blocks.]

On reviewing the records of the different Counties, it is conspicuous in how many places the sandstones or conglomerates were wrought into millstones. In some places there was a large trade not only for home but also for English uses. This trade, however, seems to be altogether a thing of the past, as nowhere, as far as we can learn, is it now followed. The manufacture of stones for flax-crushing necessarily died out when the new modes of crushing, or manipulating, were introduced; but the decline in the demand for corn millstones seems to have been solely due to the repeal of the Corn Laws, which starved out the industry, and caused it to be abandoned. Since then the few stones required are imported, principally from France. At the once famous quarries of Drumdowney, Co. Kilkenny, there has not been wrought a pair of stones since 1875, and then only one pair.

To some of the good class sandstones not now in request, as those near Thurles and Dundrum, Co. Tipperary; Doon, Co. Limerick; and others mentioned hereafter; public attention may be specially directed.

[When the modern sandstone buildings are tabulated, it at first appears remarkable that so many, even in towns at great distances from one another, are all built of stones from one quarry. On inquiry, this appears to be due to their having been built by one contractor, or under the orders of one architect, the contractor or architect having an interest in, or liking for, a certain stone. In Dublin, many of the recent Insurance Offices have in them the same stones, they all having been built by the one contractor. But this is more conspicuous in the country towns, especially in the Banks—as th

offices of one company through a large range of country will all be built of one stone, while in all those belonging to another company a different stone is used ; the stones often being brought from a distance, although better stones could be procured in the vicinity.]

GEOLOGICAL EPITOME.

The Arenaceous rocks range all through the different geological groups. It is therefore expedient, before entering into detail, to give an epitome of the present state of Irish Geology. In this the classification of the groups is that adopted in the TABLE OF STRATA in the first Paper of this series on Irish Economic Geology (*ante*, "Metal Mining," p. 8).

CAMBRIAN AND ARENIG.

[These groups are so mixed up as to necessitate their being described together.]

From the latest fossil evidence brought before the public, which is, that supposed Arenig type fossils have been found in the gneiss and schist series at Fintown, it would appear that it is now incontrovertably proved that the oldest rock in Donegal cannot be more ancient than Cambrian. Consequently, all the other similar rocks in Ireland, which some have called Laurentian, are probably of the same age or younger : that is, these metamorphosed rocks must be the equivalents of either the Ordovician, Arenig, or Cambrian.

In 1862 Jukes, and in 1863 Sterry Hunt (after Laurentian rocks were proved to exist in Scotland), suggested the possible Laurentian age of the Donegal gneiss. In 1865 Murchison announced the existence of Laurentian rocks in the Twelve Pins (*Bennabeola*), Connemara, Co. Galway ; but immediately afterwards he withdrew this statement. In the *Geology of Ireland* (1878), and subsequently in various Papers read before the Royal Irish Academy, the Royal Dublin Society, and the Royal Geological Society of Ireland, I pointed out that some of the metamorphic rocks of Donegal, Antrim, Tyrone, Leitrim, Sligo, and Mayo were probably Cambrians, but possibly Laurentians ; while Dr. Hicks immediately afterwards suggested that the rocks called

by me Cambrians in the Co. Tyrone were possibly Laurentians; and this was followed by Dr. Callaway, who, in 1881, stated that patches in my Cambrians, Co. Wexford, were Laurentians. Subsequently came Dr. Hull, who seems to consider that all the tracts of highly metamorphic rocks, except those in Wexford previously claimed by Dr. Callaway, are of Archæan age ("Laurentian Rocks in Donegal and Elsewhere in Ireland," *Trans. Roy. Dub. Soc.*, vol. i., ser. ii., p. 245). It seems remarkable that, while the rocks of the Mullet, in North-west Mayo, are included in this Paper, those of South-east Wexford should be left out, more especially as the rocks in both localities are lithologically, microscopically, and apparently stratigraphically similar, if not identical.

The Wexford rocks claimed by Dr. Callaway to be Laurentians are, as he has described them, "*a mosaic of irregular fragments*" (!) protruding into a tract of undoubted Cambrian rocks, as proved by their fossils. Nowhere else in the world have the Laurentian rocks appeared after this fashion, and I do not believe in their existence in the Co. Wexford, as the so-called Laurentians are only metamorphic intrudes of Igneous rocks and their associated tuffs, similar to the intrudes found elsewhere in every group of Irish strata, from the Carboniferous down to the Cambrian.

[From Dr. Callaway's Paper, "Metamorphic and Associated Rocks South of Wexford" (*Geol. Mag.*, Nov., 1881), it is evident that the writer had my memoir, but, at the same time, that the maps he was consulting were those published some quarter of a century prior to my being in the county or my examination of the rocks. How anyone could possibly imagine that my description was that of the obsolete maps is hard to conceive; more especially as on these maps are printed the dates of their publication and the names of the Surveyors.]

The Galway metamorphosed rocks that are said to be Laurentians are undoubtedly the equivalents of the English Ordovicians, as proved by the fossils in the unaltered portions. This will be more fully discussed when treating of the rocks of that county, while the supposed Laurentian gneiss of the Co. Donegal ought now to be disposed of, if the markings exhibited by Dr. Hull at the British Association Meeting, 1886 (*Birmingham*), are Arenig types of graptolites, which there now seems to be every reason for supposing; for if this be so, it unquestionably proves that the gneiss of Donegal, which is part of the same series, cannot possibly be more ancient than Cambrian: that is, these rocks must be the

equivalents of the rocks of the groups suggested by me in 1878, in my *Geology of Ireland*.

In the Co. Galway there are no rocks that can possibly be of Laurentian age, and the same thing may now be said of the Co. Donegal. It is, therefore, only sensational geology to say that in the intervening area (Mayo, Sligo, Leitrim, and Tyrone) there are Laurentians, more especially as the metamorphic rocks therein found are lithologically, and apparently stratigraphically, identical with the rocks in Galway and Donegal. In the descriptions of those counties in which Laurentians are stated to exist more special details will hereafter be given.

[As it has been assumed in some of the official memoirs that the existence of Archaean rocks in Ireland has been proved, this subject has to be more prominently mentioned than would otherwise be necessary. This recent finding of Archaean has been very sensational from the first. Up to the end of 1880 Professor Hull insisted that my classification was probably wrong, as the oldest rocks in Connaught and Ulster were proved by the work of the Survey to be of Lower Silurian (*Ordovician*) age. But in January, 1881, when *Drs. Hicks and Callaway* suggested that some of my Cambrians were Archaean, quite suddenly Professor Hull discovered Laurentians in Donegal and elsewhere in Ireland. After seven years of steady work in the Counties Galway and Mayo, I classified the older rocks, and subsequently traced them from Mayo into Sligo, Leitrim, Donegal, and Tyrone. The rocks of the Twelve Pins (*Bennabeola*), Co. Galway, are lithologically more similar to the Huronians of Ontario, Canada, than the rocks in any other place in Ireland. These are the rocks which, after *Eozoon Canadense* had been found in them, Murchison at one time suggested might be Laurentians; but the rocks in the same county, said by Professor Hull to be of Laurentian age, are evidently the youngest in this part of Galway, and in the westward portion of his area, where some of the rocks are very little altered, fossils possibly may at some time be found, for as yet they have not been properly searched. The rocks of the Slieve Gallion district (Co. Tyrone) and those of the Pettigoe district (Counties Fermanagh and Donegal) are partly like those of Ontario, but in them are not found the calcareous rocks so well represented in *Bennabeola*, Co. Galway. There are also other rocks in Donegal that are partly like the Ontario rocks, such as those in the long tract embracing the Gartan Lakes (*Loughs Beagh and Aribbon*), and extending from them north-easterly by Lough Keel to the south end of Mulroy Bay—bits in which area are very similar to Ontario and Assiniboia, as seen north of Lake Superior. The rocks of Crann Mountain, Co. Wexford, are also somewhat like. As to the gneissose rocks, those of Galway, on the north of Galway Bay (which evidently are metamorphosed Ordovicians), are lithologically more like the Laurentians of the Dominion and the States than any other rocks in Ireland, if we except some small patches of very limited extent in Mayo, and perhaps little bits in Sligo and Leitrim; but the gneiss and schist of Donegal lithologically are very unlike, while apparently they are identical with the metamorphosed Ordovicians of the Schuylkill River valley, Pennsylvania (*Mount Alban series*, Hitchcock, or *Hudson series*, Dana). In 1884 and 1885 the late Gerrard A. Kinahan, as previously mentioned (*ante*, p. 80), worked out an unconformability in central Donegal

between the later less altered rocks and the rocks of the older series—gneiss with their associated schists (*Gartan series*). This unconformability in connexion with those previously found by Griffith to the north-east, in the Glen valley, and to the south-east, between the rocks of the Slieve Gallion district and those to the northward, combined with M'Henry's discovery of *ARENIG* FOSSILS in the "*Gartan series*," ought to make the geology of at least Ulster quite plain;—the gneiss and associated "*Gartan series*" being the equivalents of the *Arenig* and *Cambrian*, while the later metamorphic rocks represent the upper part of the *Ordovician* and more or less of the *Llandovery* (*May Hill sandstone* or *Passage beds*), the lower portion of the *Ordovician* (*Llandeilo*) being absent in this province.]

The Cambrians or Arenig of Antrim (?), Donegal, Leitrim (?), Sligo (?), Mayo, and Galway are all more or less altered into schist, gneiss, or even granite; and in these, at the present time, no fossils are recorded, except the recent finds in the rocks of the Co. Donegal. In Co. Galway they are found in the *Ordovicians*, but not in the underlying Arenigs or Cambrians (?). In places, especially in the Co. Donegal, some of the gneiss and quartzite are very little changed, but in general all the arenaceous rocks are more allied to quartzite or quartz rock (*greisen*) than to sandstone or grits.

In Dublin, Wicklow, and Wexford, some of the Cambrians are metamorphosed, especially in the latter county, where, to the south-east, they are changed into gneiss and granite; but in places in them are quartzite and quartz rock (*greisen*), and in the unaltered portion grits and sandstones.

ORDOVICIAN and LLANDOVERY.

[In the Table of Geological Strata, "*METAL MINING*" (*ante* p. 204), the *Passage beds* between the *Ordovicians* and *Silurians* are called "*May Hill Sandstones*," or "*Llandovery*." In this Paper the latter name will be used. In Clare, Tipperary, and south-east Galway, the *Llandoверies* are more nearly allied to the *Ordovicians*; but in the Dingle promontory, Co. Kerry, they are joined on below the *Silurians*.]

Many of these rocks are metamorphosed, as more fully mentioned in the descriptions of the counties. Some of the grits and sandstones are capable of dressing well; but only a few of them are now in request for cut-work purposes, as the younger and softer stones are preferred. They were, however, used in many of the early structures, and proved good and durable stones. They were also used in many of the Pre-historic megalithic structures, as they were capable of being raised in massive slabs.

SILURIAN and DEVONIAN.

[Except in south-west Ireland (Cork and Kerry), these rocks seem to be rather mixed up. The Devonian proper are the equivalents of the "Lower Old Red Sandstone," or *Passage beds* between the Silurian and Carboniferous; but in many places, either stratigraphically or lithologically, it is hard to determine whether the rocks should be called Devonian or Silurian, as the lower beds of the Silurian (*Smerwick beds*), the upper beds of the Silurian (*Dingle beds*), and the Devonian, are all, lithologically, more or less identical. Their exact age, therefore, cannot be positively stated, except in such places as Cork and Kerry, where good continuous sections across the strata are exposed (see *Kerry*, p. 567). The lower rocks in the Silurian are usually reddish, or purplish, and over these are light-coloured fossiliferous rocks (shades of grey, green, and blue); but still higher up on these, in all the Irish tracts, there are rocks more or less similar to those below. Hereafter, in these descriptions, the reddish rocks will be called of the "Old Red Sandstone type," and the lighter-coloured rocks "Typical Silurians."]

In some of the new maps there has been a curious dividing up of the Silurians: this is especially conspicuous at Lisbellaw, Co. Fermanagh. This is an interesting locality, as the condition under which the "Lisbellaw Conglomerate" accumulated, must have been very identical with what is now going on at the Chesil Bank. In Lyme Bay the "flow-tide" current runs from the westward; and this current, accelerated by the wind-waves, carries the Chesil Beach along with it, to be accumulated in the bight behind, or westward of, Portland Bill, which acts as a groyne. Chesil Bank, or beach, becomes coarser and larger as it is followed east, till it forms a massive heap of shingle to the west of the Bill; but eastward of the Bill, in Weymouth Bay, there are finer accumulations. In Silurian times similar forces were at work in the neighbourhood of Lisbellaw. Running north-eastward from Lisbellaw was a coastline, while west of the village there was a spit, or "Bill," of Ordovician, and west of the latter a bay. Along the north-east and south-west shore the "flow-tide" current ran south-west to Lisbellaw, the shore accumulations increasing in magnitude and coarseness from the north-east towards the south-west. Thus we find at the north of Lough Eyes their conglomerates lying unconformably on the Ordovician; to the south-west is the massive "Lisbellaw Conglomerate" accumulated against the Ordovician spit, that acted as a groyne; while in the bay, west of the latter, sandstones and shales accumulate. Thus, there is a parallel in both places, as along the shore-lines the beach gets coarser and

larger down the current, till it comes to the groyne, when it accumulates, while westward of the groyne the accumulations are fine and small. On the map, for no perceptible reason, the "Lisbellaw Conglomerate" is made to belong to one geological group, and the conglomerates of Lough Eyes to another. (Vol. vii. p. 191.)

In these groups there are in places sandstone: these, from the ancient structures in which they were used, are proved to be durable, and capable of producing good work; now, however, they are not much sought after, except for local purposes, partly on account of their hardness, but more generally on account of limestone being found in their vicinity—the latter rock, in such localities, being now more generally preferred for cut-stone purposes. Quite recently, however, in a few localities they seem, in some measure, to be rising in public estimation.

CARBONIFEROUS.

The Carboniferous sea in the Irish area must have been of different depths, besides having in it islands varying greatly in dimensions. The rocks deposited in the greater depths seem, for the most part, to have been arenaceous and argillaceous (*Lower Carboniferous Sandstone and Shale*, or *Yellow Sandstone*—Griffith); but similar rocks were also afterwards deposited as littoral accumulations on different geological horizons, even up into the Coal-measures; therefore rocks of this class are formed not only under all the limestones, but also at different higher levels; they solely indicating different localities near ancient land in the Carboniferous sea. After a time, in some parts the bottom of this sea seems to have grown up, or to have been moved up, causing the water to become shallow, and the conditions more or less like those at the first, so that sandstones and shale (*Calp*), somewhat like those at the original bottom (*Lower Carboniferous Sandstone*), were again deposited.

In Munster, the adjoining portion of Leinster (*King's and Queen's Counties*), and in north-western Connaught (*Mayo*), nearly everywhere the Lower Carboniferous Sandstone occurs, margining the older rocks, and separating them from the limestone. This, however, in general, is not the case in the rest of Ireland. In the Co. Wexford, to the north-west of the limestone, are such shore

accumulations, while south-east of the trough there are none, except a few thin subordinate sandstones. West of the Leinster range, coming up from the south, these shore-rocks gradually thin out, and disappear south of Bagnelstown, not to be met further north except in small patches, such as at Newcastle, south-east of Celbridge (*Kildare*), where, we may suppose, there was a cape, alongside which a beach accumulated. In connexion with the Chair of Kildare, and the other small exposures of Ordovicians, that seem to have been islands in the Carboniferous sea, these shore-beds only occur at one side of the older rocks. Margining the large protrusions of Ordovicians in the central plain of Ireland, the Lower Carboniferous Sandstones are very continuous, while in the west of the Co. Galway, margining the older rocks, they are only found at Oughterard and Cong, in places that must have been bays. In western Mayo they are very continuous; but in the rest of that county, in Sligo and Roscommon, they, in general, only occur to the south or south-east of what was the old land: the exceptions being the tracts north-west of the western end of the Curlew Mountains (*north-east Mayo*), and those north-west of the Ox Mountains (*Co. Sligo*). In the large south-west and north-east bay, between the *Ordovician* land, south and south-west of Lough Neagh, and the *Silurian* land, between Loughs Neagh and Erne, the *Lower Carboniferous Sandstone*, except in the north-east portion, was very continuous; but to the north of Lough Erne the Carboniferous Limestones, like as at Oughterard, were accumulated against an old cliff, sandstones only being deposited to the north-east, in the Termon River valley. In the tracts of Carboniferous to the northward (*Donegal, Londonderry, and Tyrone*), the shore-beds nearly invariably only occur to the north, as in the tracts at Donegal Bay, and westward of Omagh. At Feeny, however, westward of Dungiven, there is a small tract that seems to have accumulated in a small bight, or bay, where the shore-beds were to the southward; while in Fanad, west of Lough Swilly, is the small tract to which attention has lately been directed by Messrs. Hull and Cruise, in which the conglomeritic accumulations, as pointed out in a paper by Mr. Mahony, occur along the southern shore, and silts occur along the northern.

[In the Lower Carboniferous Sandstones, and also in the subsequent "shore accumulations," there are two distinct types, the lowest beds and those on higher horizons

adjoining the shore-line, respectively, being generally of reddish or purplish colour, and more or less coarse, often conglomerates. But not always so, as sometimes they are fine red shales. Above these, or farther out from the shore, the arenaceous rocks become yellow and grey sandstone, with more or less subordinate grey and bluish shales. This graduation generally takes place upwards, but not always; as in Galway and Mayo, near Oughterard and Castlebar, you can trace, along the strike of the bedding, conglomerates graduating into sandstones, and the latter into pebbly limestones. This also can be seen in various other places, as between Ballyshannon and Pettigoe, Counties Donegal and Fermanagh. Griffith was aware that sandstones of both these colours and textures were the basal beds, or "shore beds," of the Carboniferous limestone; but, to meet the nomenclature of the day, he called the dark-coloured rocks "*Old Red Sandstone*," and for the light-coloured he introduced the term "*Yellow Sandstone*." Jukes, however, adopted a different course, as he included both together in his *Upper Old Red Sandstone*.

Of late years this merely lithological distinction has again, in places, been introduced and given an unnatural value; so that we find on the new maps little spots called "basins of Old Red Sandstone," solely because the rocks are of dark colour and coarser texture, while in other places exactly similar rocks are given their natural place: that is, they are grouped as the basal or shore beds of the *Lower Limestone*. In Western Mayo the rocks are placed in their true position; but this has not been done in Eastern Mayo, although, as pointed out by Symes, the classification into two distinct formations is "chiefly lithological" (*Geological Survey Memoirs, sheets 41, 53, and 64, page 14, and footnote by Dr. Hull*). From the description of the rocks of Western Mayo it will be seen that, similarly as Griffith mapped them, these ought also to be "*Old Red Sandstone*" in the eastern area: that is, if there is "*Old Red*" in the east of the county, it must also occur in the west, if the lithological character had been given the same value in both districts (*Geol. Mem., sheets 39, 40, 51, 52, and 62, page 16*). Griffith, and subsequently Jukes, were gradually bringing Irish geology out from the mists of the past, and it seems regrettable that it should now be plunged back again into the dark ages.]

The fauna of the lower group (*Lower Carboniferous Sandstone or Yellow Sandstone*), although it was unsuited for the clearer and deeper waters in which the associated limestones accumulated, did not die out, but emigrated to the congenial littoral shallow waters, afterwards to again spread out in later times (*Calp*), when the accumulations and conditions were favourable. Thus, we find in the Lower Carboniferous sandstones and shales, in the Littoral sandstones and shales, and in the Calp accumulations, that the rocks and their fauna are more or less similar. There is, however, in places in the Calp, a marked change in the accumulations, they being more or less calcareous, and even in places good limestone. Yet it is remarkable that in them, as in the shaly limestone of the Rathkeale district, Co. Limerick, the assemblage of the fossils is very similar to that of the Lower Carboniferous sandstone, in both being found many forms which are not to be met with in

the intervening Lower or Fenestella Limestone. It might be said that, as the fauna creeps upwards in the littoral beds from the *Lower Carboniferous Sandstone and Shale* to the *Calp*, it should have crept up by similar means from the latter to the *Coal-measures*. This, indeed, may possibly have happened, if John Kelly's classification of the Slieve Beagh series of rocks (*Counties Fermanagh, Tyrone, and Monaghan*), now favoured by Professor Hull, is correct, as these rocks, according to Baily, from palæontological evidence, ought to be classed with the *Lower Carboniferous Sandstones and Shale*. At the same time, however, a very great change seems to have taken place when the major portions of the *Coal-measures* were accumulating, as they are not essentially littoral deposits, but must, at least in part, represent land and fresh-water accumulations. Griffith's term, "Yellow Sandstone," seems better, as a general one, than "Lower Carboniferous Sandstone," as it does not express on what horizon the rock accumulated, while it suggests that the accumulations were marginal between the Carboniferous and older rocks; but the latter name seems now to be more generally preferred.

In south-west Munster the Carboniferous rocks are different, they being of the "CORK TYPE" (*Carboniferous Slate and Yellow Sandstone*). These consist, in a great measure, of slates and shales, and they graduate downwards into the Devonian. The arenaceous rocks in them are below the *Yellow Sandstone*, and higher up, on different horizons, are the sandstones called by Jukes *Coomhoola grits*. In a few isolated places the Carboniferous slate graduates upwards into *Coal-measures*; but in the latter the grits and sandstones are of small or no account. Going eastward towards Cork Harbour, the Carboniferous Slate becomes split up and interstratified with limestone; while further eastward it loses its individuality, being replaced by rocks more or less of the "CENTRAL IRELAND TYPES."

In the rest of Munster there are below, and also as littoral accumulations, the *Lower Carboniferous or Yellow Sandstone* (Upper or Carboniferous Old Red), and still higher up the grits and sandstones of the *Coal-measures*. The *Calp* here (more or less argillaceous) is a middle division in the limestone, but having in places arenaceous calcareous rocks, or, as at Castle Lambert, Co. Galway, an impure coal seam. These, however, as sandstones,

are not of much account, except that in some places they produce good flags. Here it may again be mentioned that, in the limestones of the Calp of the Co. Limerick, there are many *Lower Carboniferous Sandstone and Shale* fossils.

In Leinster and South Connaught the Carboniferous rocks are very similarly circumstanced to those of North Munster, but in North-east Connaught and Ulster there are marked changes. In the south portion of Ulster and adjoining part of Connaught there comes in as a middle group in the limestone, or as independent groups or beds on different horizons, very pure arenaceous rock; they, the *Calp Sandstones*, being quite distinct from the *Yellow Sandstones* below and the *Coal-measures* above. In these Calp sandstones, the "Fermanagh sandstones," and the Calp of the Ulster type, are procured the stones now of most note in the market. As a rule, the sandstones in the Coal-measures are considered too hard, although in Leinster some of them are really good stones; while the Lower Carboniferous stones are often ignored. This, however, may be due to prejudice or some other cause, as near Thurles and Dundrum, Co. Tipperary, there are stones said by the builders who have worked both to be better than any of the "Dungannon stones" (*Calp*).

At the present time the geology of South Tyrone, the extreme north part of Monaghan, and the adjoining portions of Fermanagh seems to be mixed up. In this area, in Slievebeagh, Carnmore, and in the country to the eastward, there are sandstones and shales that Griffith mapped as Calp, because apparently they were identical with the Calp near Dungannon, in Co. Tyrone. John Kelly, however, stated that they belonged to the Coal-measures, and called the highest group "Millstone Grits;" and in the recently published maps of the Geological Survey, John Kelly's classification has been followed, and they have been mapped as Lower Coal-measures, the lower portion being called by Phillips' local English name, *Yoredale beds*; it being here divided into Yoredale sandstone and shales, while the upper sandstones are called *Millstone Grits*.

[It seems very questionable if it is advisable to introduce English local terms into Irish geology, more especially when they are inapplicable. Anyone who has compared the Irish Coal-measures with those of England should be aware that the first can only be compared with the "Culm-measures" of Devonshire, while there is no similitude

between them and those of Yorkshire, where Phillips' name was introduced. What English geologist would attempt to divide up the Devonshire "Culm-measures" into Yoredale beds, Millstone Grits, and Coal-measures? The section of the *Carboniferous rocks* in Fermanagh and Monaghan (?) is different to any elsewhere in Ireland. Beginning below, there is—(1) *Lower Carboniferous Sandstone*; (2) *Shales*; (3) *Dark-blue, thin-bedded Limestone, with Shale partings*; (4) *Amorphous Limestone* (Fenestella Limestone); (5) *Shales and Limestone*; (6) *Sandstone*; (7) *Shales*; (8) *Amorphous Limestone under cherty Limestone*; (9) *Sandstones*; (10) *Shales*; (11) *Sandstones, &c.* The groups 9, 10, and 11 belong to the Lower COAL-MEASURES, and 9 and 10, or Lower Coal-measures, may be called the *Fermanagh series*, after the county in which they are best developed, and not after "Yoredale," where the rocks are different. Group 11 is a portion of the Middle Coal-measures. Groups 1 to 4 are somewhat like the rocks of Munster; but groups 5 to 10 are of different characters and arrangement]

This tract is interesting. If we begin to the eastward, we find sandstones and shales, with small coals, to the north of the TYRONE COAL-FIELD (Dungannon), where undoubtedly they belong to the middle or Calp division of the Limestone. In them, as pointed out by Hardman (*G. S. M.*), there are fossils of Coal-measure types. South-west and westward of Dungannon are small tracts of similar rocks; also farther south-west—north-east, south-east, and south of Aughnacloy, all of which appear on the new maps as Calp sandstone; but immediately after we cross the Blackwater—that is, leave the Aughnacloy area, and go south-west—the apparently similar rocks in the district of Slievebeagh are mapped as Yoredale beds and Millstone Grits. Baily contends that these rocks ought to be mapped as *Lower Carboniferous Sandstones and Shales*, as the fossils are of these types; while Kilroe states it is difficult to see any difference between the rocks of the Slievebeagh district and those of the Calp (*G. S. M.*). In these rocks of this *Fermanagh series* (as it will hereafter be called) and in the acknowledged Calp the sandstones are very similar, the "Dungannon stone" in the Calp and the "Lisnaskea stone" in the Fermanagh series being of one class and equally in repute. In the Calp sandstones north of the *Tyrone Coal-field* and in the Lisnaskea quarries have been found similar large fossil trees, while the assemblage of fossils in the Fermanagh series, according to Baily, is that of the Lower Limestone Sandstone and the Calp, and is not like that of the Coal-measures. But as the section in South-east Fermanagh, between Lisnaskea and Slievebeagh, is identical with that of the known Coal-measures in Belmore and Cuilcagh (West Fermanagh), it is evident that these rocks of the

Slievebeagh district must, at least in part, represent the *Lower Coal-measures*, although they are so different lithologically from those of the TYRONE COAL-FIELD to the eastward.

But it must be remembered, as pointed out in my *Geology of Ireland* (1878), that in the Coal-measures of North Connaught there is a marked change, the lithological characters of the *Lower Measures* being very different to those elsewhere in Ireland; as below, immediately above the *Upper Limestone*, a more or less thick group of sandstones appear, with subordinate argillaceous and calcareous strata; while in the *Middle Measures* there are three coals, one of value. In Tyrone also, but not elsewhere, are found workable coals in the *Middle Measures*.

In North Ulster there are other peculiarities, as the rocks appear to have accumulated in bays or seas of limited extent; and the different groups of rocks, elsewhere capable of being separated, become mixed up; the red and yellow sandstones, the different types of limestone, and even shales, identical, except in fossils, with those of the Coal-measures, being more or less mixed up. These rocks, which may be called the ULSTER CALP TYPE, occur nearly altogether north of a line drawn from Lower Lough Erne along the Silurians of the Fintona district to Lough Neagh, excepting the rocks near Cookstown, Co. Tyrone, which are south of this line, and have some characteristics allied to those of the "Ulster Calp type."

The upper group, or the COAL-MEASURES, has, as *Lower Measures* in East Ulster, some five hundred to seven hundred feet thickness of shale, over which, in the *Middle Measures*, arenaceous rocks predominate, while in the *Upper Measures* there is a mixture of arenaceous and argillaceous rocks, with coal. But in North Connaught, and the adjoining part of Ulster, there are immediately above the upper limestone more or less arenaceous strata, and above these shales, and these combined represent the *Lower Measures*. Above these are the *Middle Measures*, which are for the most part arenaceous, but having in them workable coals. In Eastern Ulster (Tyrone), although the strata of the Coal-measures occur in a very similar arrangement to those of Leinster and Munster fields; yet in the *Middle Measures* there are valuable coals.

At the present time the Coal-measures Sandstone of Ireland,

except those of the Fermanagh series, are not in repute, although, as displayed by some of the ancient structures, they are capable of good and durable work. This will be hereafter mentioned in connexion with the respective counties.

In the *West Munster Coal-fields* the stones are nearly invariably hard and chippy, and although they can be dressed on the face of the beds, they cannot be worked across, as they chip and fly at the edges. In places they produce excellent flags, but to give good joints, the edges of them generally require to be sawn, as they chip on the face if dressed. These flags, if the edges are sawn and the surface planed, make a beautiful even flooring. In the *East Munster* (Tipperary) and *Leinster Coal-fields* there are some good stones for dressed work, as hereafter mentioned. In the *Tyrone or Ulster Coal-field* some quarries have been worked, but the stones are not in request, as better can be procured in the adjoining calp; while in Monaghan and Fermanagh are the well-known Lisnaskea stones; and in the CONNAUGHT COAL-FIELD there are stones said to be good; but as they are very inaccessible, and far from any market, very little seems to be known about them. Good flags, however, have been sent from this field into the market; at one time extensively.

[The flag trade has peculiar features. About fifty years ago, according to the records left by Lewis, the footpaths of very few towns were flagged; but just at that time it seemed to have become the fashion, and the different towns were looking out for places in which to procure flags. This general demand caused many flag quarries to be opened up, and in some places instituted a large industry. But after the towns were flagged the demand decreased, some of the quarries having been scarcely worked since, while in those places where a trade had been for a time established, it has since died out, on account of asphalt being now more generally used than flags. However, there seems to be a slight reaction in the favour of flagging, as the asphalt in many places seems to be getting into disrepute. In various places in Ireland there are large flag quarries, where hundreds of hands were employed, that now are quite idle. Belgium sends into the market a large quantity of chimney-pieces, made of flag very like that of our Coal-measures; and fifty years ago a large trade in somewhat similar work was carried on at Killaloe, Co. Clare, and other places, the Killaloe chimney-pieces "being in very general request." Now a "Killaloe chimney-piece" is not heard of, the trade having totally died out; while in the Moneypoint flag quarry, on the Lower Shannon, from which the flags came, instead of hundreds of workmen, you will rarely find half a dozen. Very superior work of this class used also to be turned out from quarries near Mountmellick, Queen's County, and other places hereafter mentioned. The Belgians do their work "by the piece." A man is paid so much for the job; and he, his wife, and his children, down to a child that can scarcely walk, are put to do something at which they work early and late. In Ireland,

however, such things are nearly invariably done by days' work, in limited hours, consequently in one case the work can be done much cheaper than in the other, and the goods sent into the market much cheaper. The Belgian chimney-pieces now in the market are enamelled, which was not the case with the Irish chimney-pieces formerly in the market. It is for a similar reason—"cheap labour"—that the Belgian red marbles have cut out, in the English markets, the "Irish reds," although the latter are superior.]

PERMIAN.

In a few places there are conglomerates and sandstones said to be of this age; but in some places those supposed to be Permian are probably Carboniferous, and in others probably Triassic; they being the upper beds of the first, and the lowest bed of the other.

TRIASSIC.

The sandstones, or *Redfree*, as they are generally called, are free-working stones, and capable of producing fine work. They, however, except in a few places, are not durable, also most of them are liable to discolour; and although the stones may be selected with great care, yet nearly always some will become unsightly, spoiling the general effect; still buildings with dressing and quoins of these sandstones, and walling of limestone, or even basalt, have an effective appearance. Exceptions to these general characters are the stones of North Down, Scrabo, and Dundonald, as from these, especially the latter, stones of good repute are procured. The hard texture of these may possibly be due to the associated igneous rocks.

JURASSIC, CRETACEOUS, EOCENE, AND DRIFT.

In the groups of strata later than the Triassic the few sandstones that occur are of little account for building purposes, they nearly invariably being too frail to be thus used. Some of the drift sandstones are only in course of formation at the present time, sand and gravel being cemented together by water percolating through them, charged with carbonaceous, silicious, or ferriferous matter.

SAND AND GRAVEL.

In a few of the older rock groups there are *sands* that occur as rotten or disintegrated portions of beds of sandstones or other rocks. These, however, are comparatively rare, as the principal places in which the sand and the gravels are found are as portions or beds of the *Drift*, *Alluvium*, and *Diluvium*. Under the latter circumstance they often occur in considerable quantities; in some places younger drifts being made up nearly altogether of them. They have been used in the manufacture of glass, for building purposes, for manure, and many of the gravels for road metal.

The coast sands, that is, those found in the tracts and dunes of *Æolian* sand, which occupy such long and sometimes wide tracts in places round the coast-line, seem capable of being made much more remunerative than they are at present. If no other use can be found for them they ought to be planted, as has been done in Gascony, and other places on the wild coast of the Bay of Biscay. Their frail nature, and tendency to travel, has given them a bad name; but experience in France proves that they will grow fir timber profitable for turpentine and pitch; while after the woods are established, the shedding of the leaves and the roots of the trees fix the sand so, that portions, if judiciously cleared, can be converted into excellent and remunerative tillage-land. It should, however, be mentioned, that in Ireland, in a few places, by judicious management, they have been made more or less remunerative.

Many of these *Æolian* sands, especially when Calcareous, ought to be extensively used as manure. Some of them were utilized for this purpose formerly; but of late years nearly all are ignored, as the artificial manures can be more easily procured, although eventually at a much greater cost.

There are other sands, also gravels, valuable as manure; these will be mentioned in their respective counties.

For the ancient bronze castings the mould in general seems to have been cut in sandstone, as many such moulds are found in the old settlements. In modern times they are generally made of sand. As to where the sand used for these moulds in the different foundries was procured we can give very little information.

Adjoining the Arklow Chemical Works a barricade of upright timbers was erected to prevent the mass of *Æolian* sand, during

east and north-east gales, from drifting and blocking up the quay and entrance to the works. Through the fine joints of the timbers in this barricade a minute silicious sand drifted, and this has been found to be highly valuable for use with the saws of the marble and other stone-cutters, it being sent to Dublin for these purposes. Ireland seems to be remarkably deficient in "sharp-sand" suitable for stone-cutting, most of it being imported. Here, therefore, there appears to be a suggestion as to the introduction of a new industry; for in different places along these Arklow Æolian sands, or on the other accumulations of silicious sand along the south-east coast, similar barricades to that at Arklow might be erected, and the fine sand drifted through them sent into the market to meet the present deficiency.

GLASS.—As to the former Glass trade, we have the records of when it was established; but in most cases it is impossible now to find out where the sand came from. In some cases, however, we know that Irish sands were used. As glass beads are common as Irish antiquities, they seem to suggest that in old times our sands, in different places, were used in the manufacture of glass.

In different cases, as will be hereafter seen, the qualifications of a stone is a vexed question; as what one authority approves, another disapproves. Where the opinions are conflicting, the names of the authorities are given. In many cases this disagreement may be more apparent than real, as in most quarries there are different classes of stone—one sent to one market, another to another—so that the opinions expressed, although apparently in reference to one and the same stone, may not be so. Also, in some of the quarries all the good stone, once in good repute, may be now exhausted. Fifty years ago all the builders knew the "Slush stone," Co. Fermanagh; while if you ask the men of the present day their opinion of it, probably they never heard of it, its day having long since passed away, as the good stone in it has now become too expensive to work on account of the "off baring."

Necessarily, in a Paper of this kind, some of the statements may require modification, or other correction; while there may be quarries left out of the lists that ought to have been mentioned. Such omission, however, will, as far as possible, be corrected hereafter in an Appendix.

The descriptions are given in the counties, arranged in alphabetical order, under the different Geological groups, as adopted in the Table of Strata in the Introduction to the Paper on METAL MINING (*ante*, p. 8). The records of the Sands and Gravels are not as full as they ought to be; but on these subjects it is hard to get satisfactory information, as most previous writers have, in a great measure, ignored them, except in general description, from which very few details can be learned.

In the compiling of this Paper, as in the previous one on "Marbles and Limestones," I have necessarily been greatly indebted to Wilkinson's standard work; and of all stones mentioned by him his descriptions are given, except that his arrangement is modified to suit mine. I have also consulted Lewis, and the Memoirs of the Geological Survey, the quotations from the latter being initialed *G. S. M.* But the information from Lewis cannot be specially acknowledged, it being too general, and having afterwards to be verified. I have also received valuable information from the Officers of the Board of Works, through Mr. Commissioner S. U. Roberts; some of the County Surveyors, and various private individuals; whose aid, when possible, has been acknowledged; but in many cases this was impossible, as the same information was received from different sources, or the different information about one place had to be incorporated.

COUNTY HISTORIES.

ANTRIM.

ARENIG (P) or ORDOVICIAN (P).—To the north-east of the county, principally in the barony of Cary, now better known as the Ballycastle district, is a considerable tract of metamorphic rocks, probably the equivalents of either the Ordovician or Arenig. Among these are some rocks that still in part partake of the nature of grits or quartzite, but none of them are eminently suitable for cut-stone purposes.

SILURIAN.—On the east coast, in the neighbourhood of Cushendun, there are massive conglomerates associated in places with sandstones. These rocks seem evidently to be a portion of the littoral or shore beds of the *Ulster and Connaught Silurian Basin*, heaved northward by the faults of the Lough Neagh valley.

In places some of the conglomerates can be raised in blocks very suitable for piers and other rough work, while some of the finer beds can be used for cut-stone purposes. "The fine beds at Cave House were at one time largely quarried, and shipped to Belfast for building purposes" (*G. S. M.*).

CARBONIFEROUS.—Near Benmore, or Fairhead, is a small tract of *Ulster-type Calp*, where there were some workable beds of coals, for which reason it is commonly known as the **BALLYCASTLE COAL-FIELD** (see *Antrim*, "Metal Mining," *ante*, page 68). Here are some stones of great durability; but as some beds are better than others, they should be selected with care and judgment. The best stones are whitish or creamy, finely granular, nearly entirely silicious, but slightly micaceous, and having a few iron spots. Some beds, although otherwise good, are liable to discolour.

Ballyory Quarry.—Three miles from Ballycastle, where there is a railway station. Wilkinson thus describes the stones: "Best stone very fine-grained and friable, almost entirely silicious-grained, slightly micaceous, and with a few iron spots; works easily and well. In selecting the stone, blocks showing iron spots should be rejected." But Mr. Gray says: "Irregular in texture, gritty, and in many beds soft. Carefully-selected stones stand exposure; but as a rule it is not a good stone."

In colour it is pink-white or creamy. Of the latter there are two kinds, one coarse-grained and very strong, admirably suited for bridges, piers, and other strong work. It has been used for many of the bridges in the Co. Antrim, including the viaduct, in places 90 or 100 feet high, over Glendun, in the latter having been used in all the most particular and trying parts. This viaduct has now been a great many years built, and there are not the slightest symptoms of decay in any of the Ballycastle stones used therein. The Ballycastle bridge, after it was carried away, was rebuilt in 1852 with this stone, and the chisel brushings are now nearly quite fresh. Here the durability of the stone has been considerably tested, as during spring-tides they are wet, and

at other times, especially during the heat of summer or in frost, quite dry. These tests the stone has stood well.

The second is a fine stone, taking a beautiful edge, and suitable for the finest work. It can be worked on any surface, where it is equally durable, as it does not require to be laid on its own bed. The spire of Ballycastle Church, built in 1756, is of this stone, and has remained perfect ever since. It was also used for dressing, facing, and other purposes at Doon Hill, Co. Londonderry, built by Lord Bristol, then bishop, in 1783 to 1785, and the cornices and fine work are still quite fresh. In Belfast it contrasts favourably with other sandstones. The spire of the Charitable Institute, built 1774, is of this stone, and also the portico of St. George's Church. The latter was originally in Lord Bristol's palace of Ballyscullion, and was removed to Belfast after the palace was burnt down. These have shown no signs of decay, while English, Scotch, and other stones in the Belfast structures have had to be painted or re-dressed. This stone was also used for the dressings in the Grain Market; and in Coleraine for the inside dressings in the church. It was formerly used largely for Tombstones, but at present only a little.

In Ballymena, the nearest large town, it is not now used, as the Scotch stones are cheaper. The Dungannon stones, Co. Tyrone, are, however, still cheaper, costing 4s. a ton, while the Scotch is 10s. The spire and dressings of the west church are of the Dungannon stone, while it is also generally used for window-sills and such like. The quarries about Dungannon yield different stones. From Bloomhill come the stones most used and preferred in Ballymena; but in Belfast they prefer the Ranfurly and Carlan stones.

Fair Head.—Red. Works freely; durable; used throughout in the Ballycastle Coastguard Station. (*J. Cockburn.*)

TRIASSIC.—This occurs more or less as a fringe, margining the later rocks to the eastward. It is commonly known as "Red Free." This sandstone works easily and finely, but almost invariably it is very friable and weathers quickly. Some of the hardest stones are quarried in the vicinity of Red Bay and at Bank Head, near Larne. There are also various quarries in the valley of the Lagan.

For Belfast the "Red Free" is usually brought from Scrabo and Dundonald, Co. Down, where the stone is much harder and

better than in the Co. Antrim. The principal sandstones used in Belfast are given under Co. Down.

CRETACEOUS.—In places, under the White Limestone (*Indurated Chalk*), are sandstones, supposed to represent the English Greensand. These are locally known as *mulatto stones*. They occasionally are firm enough to be used as building stones; but in general, as pointed out by Wilkinson, they are “too friable and loose-grained to be suitable for good work.” Du Noyer has stated that, in the Cretaceous rocks of Colin Glen, there are some fine-grained, thin-bedded sandstones, which were used for lithographic purposes.

FLINTS.—The flints in the White Limestone, as mentioned in the Paper on “MARBLES AND LIMESTONES” (*ante*, page 165), were, in prehistoric times, largely used for the manufacture of arrow-heads and other implements, being exported into the neighbouring counties. In later times they were wrought into gun flints. So late as 1840 there was a large export of flints from the Whiterock quarries, near Dunluce, to supply this trade and the Staffordshire potteries. Since then flints have been exported from Glenarm and other places for the English potteries and that at Belleek, Co. Fermanagh; while the Eglinton Chemical Co. grind up the flints, and from the powder manufacture silicious bricks, that can stand any heat, and are in great request for the lining of steel furnaces.

AGATES.—Some of the flints on Rathlin Island are ribanded, and appear capable of producing beautiful “onyx” and “sardonyx,” if we may judge from the specimens in the Science and Art Museum, Leinster House, Dublin. As is well known, the old Greeks and Romans, who ranked agates high among their precious stones, invented a method of staining them. This for years remained a secret with the Italians, till an Italian and German, at one and the same time, both agate cutters, got into trouble in Paris, and while in prison together the Italian communicated the secret to the German. Since then the great trades in agates at Oberstein in Germany has sprung up, the major portion, if not all, the rough agates being imported from the La Plata River, America, the German quarries falling into disuse after the American cheaper supply came into the market.

As far as we can learn, there seem to be no records of these Rathlin agates in Leinster House as to whether they are the

stones as found *in situ* in the island, or if rough agates that afterwards were stained. In the Ballinascreen Hills, northward of Draperstown, Co. Londonderry, the "chalk conglomerate," the basal bed of the Eocene, is in a great measure made up of broken flints, that were baked by the subsequent overflow of basalt. In all the naturally stained agates I have seen the colours developed are shades of red, they being of the "carnelian" type, as may be seen in the flint fragments *in situ*, and in the flint implements found in the valley of the Lower Bann, Co. Londonderry. Symes states that the agates of this class are common everywhere in the North of Ireland, where the basalt lies direct on the Eocene basal conglomerate, that is the rock due to the breaking up and re-arrangement of the surface of the limestone. He suggests that the staining is due to an iron solution, combined with the baking due to the overflow of hot basalt. The process must be more or less allied to the artificial production of "carnelians;" but as the natural ones are more opaque than the artificial, an iron solution, as suggested by Symes, may be present. At present we are unable to say if the Rathlin "onyx" and "sardonyx," as seen in the Science and Art Museum, Leinster House, Dublin, have been procured *in situ*, or if they were afterwards artificially stained. The stones, however, whether naturally or artificially stained, give such good results, that they ought to be worth looking after; not, however, for a trade in the island in cutting and polishing, for labour is so cheap in Germany that it would be impossible to compete therewith; but the raw material might be exported to Germany, as it is at the present time from the River La Plata.

[In the "GEOLOGY OF INDIA," Pt. iii., pp. 506, &c., Ball gives an interesting and exhaustive account of agates, and how the colours are produced. Many of the raw Indian agates are identical with those from Antrim, while their origins seem to be very similar, both being baked by overflow of basalt. Besides being used for ornamental purposes, they are largely manufactured into burnishers.]

SAND AND GRAVEL.—As a subordinate adjunct of the flows of Eocene basalt, Lewis records a rough tripoli found at Agnew Hill.

In various places in connexion with the Drift, the alluvium and the diluvium, are sands and gravel. In the drift near Ballycastle

there are valuable sands, due to the weathering of the sandstones of the "Ballycastle Coal-field" (*Calp*), mentioned under *Glass* hereafter. Red sand suitable for foundry purposes is procured in the valley of the Lagan, and exported from Belfast.

In the valley of the Bann is a deposit of *Diatomyte*, or "Diatomaceous clay." This, although properly a sand, is so fine that it has come to be regarded as a "clay," and the notice of it in this and other counties will hereafter be given in a subsequent paper on "Slates and Clays."

For mortar, excellent *river-sand* is procured from Lough Neagh, near Antrim. Near Lisburn and Ballymoney there is *pit-sand*; but as the latter is mixed with clay bands, it has to be carefully raised. At Hollywood there is good sand; at Ballycastle, as already mentioned, there is also good sand; and at Larne there is *sea-sand* on the beach.

In some places on the coast-line there are *Æolian sands*, that are carted inland, to be used as manure, especially on peaty soil. At Red Bay the *Æolian* sands bring large rents, they being rented and cultivated by the inland farmers for potatoes, to change the character of the seed, a worn-out stock being renovated after it has been grown in these sands.

GLASS.—In the neighbourhood of Ballycastle there is an excellent sand, due to the weathering and washing of the Carboniferous sandstone. This seems to have induced the manufacture of glass at a very early period, possibly in prehistoric times (see *ante*, page 69). Of late the glass trade was for the most part an export of bottles to Scotland. It declined as the native coal increased in price, and finally died out when the glass-house was destroyed by lightning in 1850, or thereabouts.

ARMAGH.

A considerable portion of the county is occupied by *ORDOVICIAN*s; but none of these sandstones, or grits, seem to be favourably received as a building stone.

To the north of the county, in the Blackwater Valley, are *CARBONIFEROUS* sandstones. Some of these, of reddish colours, were said to be of *PERMIAN* age; but the fossils in them suggest

that this cannot be correct. Some of these sandstones will dress fairly well, but they are not in general request.

Grange. North-north-east of Armagh.—A free-working, fine sandstone, considered to be inferior to the “Dungannon stones,” Co. Tyrone, and those of Lisnaskea, Co. Fermanagh. It was used during the restoration of the Armagh Cathedral in 1835; but for the dressed work foreign stones were used, as presently mentioned.

At Armagh there are conglomerates that are said to be Permians. Possibly they may be of that age, that is, the “Passage rocks,” from the Carboniferous to the Trias; but it seems more probable that they are the basal beds of the latter. They lie nearly horizontal, as do also the Carboniferous rocks below, and the Trias rocks above, so that their exact age is hard to determine. These formerly were rather extensively used for ordinary building purposes, and some beds for flagging in Armagh.

TRIASSIC.—Sandstones, or “Red Free,” occurs to the North of the county, in the valley of the Blackwater, and at Armagh, and seem formerly to have been utilised; but of late they are not of repute. Between 1840 and 1845, when repairing the Cathedral at Armagh, “English reds” were used for the carved head, while about the same time Scotch stones were imported for Lord Lurgan’s new house.

In the vicinity of Armagh, near Redbarn, at the bottom of the red beds, either in the Trias or the so-called Permian, is a Calcareous, hard, red breccia that has been used for flagging in Armagh.

SAND AND GRAVEL occur in the drift alluvium and diluvium. Good sharp sands for building purposes are found on the shores of Lough Neagh, near Lurgan, while good *river-sand* occurs about two miles from Armagh.

CARLOW.

The only sandstones and grits belong to the CARBONIFEROUS. They occur in the Lower Coal-measures that extend from Kilkenny and Queen’s County into the western portion of the county. Although not now in request, being only used for local building purposes, they are capable of fine and durable work, as may be seen in the exquisitely carved and beautiful doorway of the ancient church in Killeslin Glen. The principal quarry in them is

at *Killeshin*, about two and a-half miles from Carlow, on the road to Castlecomer. The stone occurs in nearly horizontal beds, from 10 to 24 inches in thickness, of a brownish-grey colour, silicious, naturally jointed, and easily raised. From the same strata are procured the so-called "Carlow flags." The principal quarries for these flags are, however, in the Co. Kilkenny, as is afterwards mentioned.

SAND AND GRAVEL.—Sand is found in the alluvium and diluvium, while the upper drift (*Esker drift*) above the boulder clay or glacial drift is nearly altogether gravels and sands. These, in places, are cemented into a conglomerate bed, having associated with them beds of brick clay, to be subsequently mentioned in a Paper on Slates and Clays. Good *pit-sand* can be procured in all the pits, which are numerous in the valley of the Barrow, but perhaps more in the Queen's County (west of the river) than in Carlow.

There is a large extent of good *pit-sand* and gravel at Carlow town, about the railway station, and along the roads running out at that side, where they form the lower stratum of the alluvial soil for a considerable distance.

CAVAN.

The sandstones belong to the Ordovician and the Carboniferous.

ORDOVICIAN.—These rocks, although of considerable extent, contain few rocks eminently suitable for cut-stone purposes. Some, indeed, work fairly well; but as good limestone or sandstone of a later age are conveniently situated, they are not looked after.

Scrably. North of Lough Gowna; eight miles from Granard.—Brownish, ferriferous, slightly calcareous; works fairly, but is liable to lose its colour.

CARBONIFEROUS (*Lower Carboniferous, or Yellow Sandstone*).—In this group, in the neighbourhood of Cavan, there are some easily-worked stones of a yellowish-grey colour, that have been extensively used in the town.

Latt and Ballyconnell (Cavan).—Yellowish-grey, silicious, durable; works freely. Used in the Cullen College, built 1871.

To the north-west of the county, in the Coal-measure of the Cuilcagh and Benbrack Hills, there are said to be some beds of good stones. These, however, have been rarely worked, and, for the most part, are unknown on account of their backward situation, and the difficulty and expense of bringing them into the market, railway charges being so high. They were, however, once largely wrought into millstones, and next to those from Drumdowney, in Kilkenny, were highly esteemed.

SAND AND GRAVEL.—Usually these are scarce in the county, especially near the capital town, as for building purposes sand has to be procured from a considerable distance. At Bailieborough there is a red *pit-sand*, but not very good.

CLARE.

ORDOVICIANS occur in the mountain groups of Slieve Aughta and Slieve Bernagh. In these are grits and sandstones, but not of much account, except for rough work. There is also a green rock, full of little round bits of quartz, from the size of shot to that of peas, locally called “*Porphyry*.” It is a hard massive stone, good for heavy work, but rises in unsightly blocks.

CARBONIFEROUS.—Margining the Ordovicians, and in a small outlying exposure between Newmarket and Bunratty, are *Lower Carboniferous Sandstones (Upper Old Red)*. The stones vary much in colour, from nearly white to yellow, reddish-yellow, and red or purplish. Good stone can be got in many places; but there are so many good and large surface-blocks, that only a few quarries have been opened. The stones in the hills, about ten miles from Scariff, have very silicious grains in a felspathic cement; they work rather easily, but wear the tools rapidly.

Ballyheigue. Near Scariff. — Yellowish, gritty, with little cement; ferruginous spots; not difficult to work. In 1842, and following years, this stone was extensively used in the works for the improvement of the Shannon at Killaloe, and subsequently was used for the Workhouse, Scariff; but in Scariff it is not much used, as they prefer the stones procured in the hills, about ten or twelve miles distance.

A vein of excellent stone, equal to the Tyrone stone, is said to

exist near Mount Shannon, at the bounds of the Co. Galway and this county.

As pointed out by Wilkinson, the stonework of the ancient Crypt and Cathedral at Killaloe attest the durability and quality of the sandstones of that neighbourhood.

To the west of the county, in the *Coal-measures*, the sandstones and grits are usually thin-bedded, brownish, and bluish-grey, close-grained, and compact. They are very good for general building purposes, being very durable, and having flat beds, make very strong, good work; otherwise, they are not much used, being expensive to quarry, on account of the great head (over-baring) of drift. They are also difficult to dress, and for out-stone purposes limestone is generally used in the district.

Ennistimon.—In beds or layers, from 2 to 8, or 10 inches thick. Dark-grey; close and compact; very silicious. Makes good walling. Very difficult to work.

Crag. One mile from Kilrush.—Flags like those at Money Point.

Money Point (on the Shannon).—Flags somewhat like the Carlow flags, but much darker; rough on the surface from tracks of marine worms and other animals. They have been extensively quarried, and exported to different places along the coast of the south-west counties. Formerly they were extensively manufactured into chimney-pieces, at the Marble Works, Killaloe, where there was machinery for cutting them and planing their surfaces. At one time the Killaloe chimney-pieces were well known in the market, and the Works employed a large staff of men, women, and children. Some thirty years ago, however, this trade seems to have died out, and now the "Killaloe Marble Works" exist only in name.

[The history of the Killaloe Marble Works I have not been able to unravel. Killaloe is most favourably situated, having the command of the greatest water-power in Ireland, and ought to be one of the great centres of industry; but for some reasons all this great water-power is allowed to remain idle. Prior to 1850, the Killaloe Works were a great source of employment, not only in the town, but in the flag quarries on the Lower Shannon, and in various marble quarries, principally in Counties Tipperary and Limerick. All of these quarries seem to have failed when the Killaloe Works ceased.]

SAND AND GRAVEL.—Very superior crystalline sand is found on

the shores of Loughs Graney and Coutra. The former were extensively used for the manufacture of scythe boards, the sands being carried for that purpose into the neighbouring counties, as boards made from them were considered far superior to those made from English sands. This sand is the detritus from the Lower Carboniferous sandstone, in which there are beds that were formerly wrought by hand into scythe stones. These were carried by hawkers, and sold to the traders in Ennis, Limerick, Nenagh, &c., or at the different markets and fairs in the neighbouring portions of Connaught, Munster, and Leinster. Before the "bad times" in 1848 and subsequent years, very few mowers along the Shannon and its tributaries used any but "Clare stones" and "Clare boards;" but during that time the making of them ceased, and English and Scotch stones had to be used. A few of the makers who survived the famine attempted to revive the trade, and in 1860 there were a few families in Glenomera and Glendree, near Feakle, working at them. The foreign stones, however, held their own, as they could be sold much cheaper; also they suited the scythes then in the market, as those imported are much softer than those previously made in the country, the former wearing out much quicker than the latter. Fifty years ago a mower on the Callow, along the Shannon, would have a scythe to last him two or three seasons; now the imported scythes never last more than one. The cheap scythes retard the work considerably, as the mowers have to stop so often to whet their scythes.

[As pointed out in the Paper on "Metal Mining" (*ante*, page 110), the Irish iron was much superior to that now in use. There are not now, as far as I can learn, any authentic records as to the quality of the steel, except the traditions of certain smiths who could make a scythe that would "cut wool floating on water," or a scythe that had not to be whetted for an entire day. Such legends are still to be heard in the neighbourhood of the Shannon and elsewhere.]

In the barony of Burren sand and gravel are scarce, being nowhere in abundance. In the neighbourhood of Ennis there is good *pit-sand*; three miles from Scariff there is good *river-sand*; while at Lahinch and Kilrush there is good *sea-sand*.

In places along the coast-line there are duns or accumulations of *Æolian sand*, and in the estuary of the Shannon *manure or shell sand*, formerly extensively utilized.

CORK.

In this county sandstones and grits are the principal rocks, they being of *Silurian*, *Devonian*, and *Carboniferous* ages. (See note on *Old Red Sandstone*, under *Kerry*, page 266.)

SILURIAN AND DEVONIAN.—The rocks of the hill country to the north and west of the area nearly all belong to one of these divisions, Carboniferous rocks only being found in portions of the valley. The Silurians (*Glengariff grits*) and Devonians (*Lower Old Red Sandstones*) are locally called “brown stone” and “red stone,” while the Carboniferous sandstones (*Yellow sandstones* and *Coomhoola grits*) are known as “grey stone.”

In numerous places in the Silurian and Devonian excellent and durable stones for tool-work could be procured, as is exhibited in the various ancient buildings, Limestone, however, is now generally used for dressings and other cut-stone purposes. This, in a great measure, seems to be due to the architects and workmen, who have learned and live in the cities where limestone is used, objecting now to use the sandstone; the workmen especially, as sandstones are much harder on their tools than limestones. Limestone, however, in early times, in places superseded the sandstone, as at Cloyne, where the sandstone in the Round Tower was procured between its site and the shore; while the other ancient structures, but more recently built, are of limestone brought from a distance.

The Round Tower of Cloyne, just mentioned, displays the excellent qualities and durability of the stone of the neighbourhood. It is of a light, brownish-coloured sandstone, the work being good, especially round the doorway. Of the work Wilkinson states that the stones are notched one into the other in a peculiar manner; also that their state of preservation shows the durability and sound quality of the material.

From the list given (page 243) and descriptions, for which I am indebted to Mr. Williams of the Board of Works, it would appear that some of the South-west Cork sandstones are well worthy of more attention than they now receive.

Sherkin Island, off Baltimore Harbour.—The stone, when first raised, is greyish; then it becomes tinged with green, probably

due to minute particles of grey copper. It afterwards loses the greenish tinge, but never returns to its primitive colour. It has been extensively used in Skibbereen, where it displays good work, especially in the Roman Catholic church; while its durability is tested in the older buildings. This vein of stone is of considerable extent, being found to the westward in Clear Island, and eastward on the main to the south and south-east of Baltimore Harbour.

Horse Island.—A loose, friable, brown freestone, which has been extensively quarried.

Drumcona, six miles from Skibbereen.—Greenish; hard; semi-vitreous, with calcareous patches; cuts and dresses well. This is a superior stone to those on Sherkin; but the quarry is very inaccessible.

Glandore.—A good greenish grit, formerly much used. In the ruins of Ballymoney Castle its durability is tested. It was also used in Kilcoleman House, four miles from Bandon.

The quoins and chimney shafts at Aughadown House, in the east division of the barony of West Carbery, are good examples of the stones of the neighbourhood.

Knockarowra and Cloghlucas, near Mallow.—Brownish-grey; slightly argillaceous; suitable for plain work.

Rahan Mountain, four miles from Mallow.—Reddish; ferruginous; fine-grained. A superior stone to those nearer Mallow.

Quarry Mountain, near Mallow.—Reddish; silicious, but slightly calcareous; semi-crystalline.

Mountain between Mallow and Kanturk.—Dark-brown; quartzose; semi-vitreous; hard.

Knightfield, three miles south-east of Banteer Railway Station (commonly known as the "Kanturk Quarry").—Used for the quoins and sills of the Lismore school, six miles from Kanturk.

[The following two localities in the Knockmealdown range may be in the "Yellow Sandstone."]

Killemera, near Glanworth.—A nice sandstone for walling purposes.

Araglin, north-east of Fermoy.—Grit stone; gives well-shaped, superior paving setts.

Two miles south of Fermoy is a very good variegated stone, that cuts and dresses well. It was much used formerly, but after-

wards was in a great measure superseded by limestone. Bishop's Wood, near Fermoy, supplies flags.

Glanmire Road, Cork.—A deep-red, fine-grained stone.

Templegall, or Whitechurch, seven miles north-west of Cork.—Good building stones and flags.

Youghal.—A red stone, lighter in colour than the Cork stone.

In places there is a conglomerate (trappean), which can be worked into good square blocks, best suited for heavy work, such as bridges, foundation walls, and the like.

CARBONIFEROUS.—In this formation there are sandstones and grits at the base (*Yellow Sandstone*); and higher up in the *Carboniferous Slate*, at different horizons, are the Coomhoola grits. In places many good stones could be procured, but they are not much sought after, being hard and silicious, and quickly wearing the workman's tools.

A good freestone has been worked on *Horse Island*; also near Castletownsend; while, in the Devonshire property, near Bandon, and in the Herrick estate, Innishannon, there are extensive quarries.

In the parish of Brinny, north-east of Bandon, are flags of excellent quality, and in Kilbrogan there is freestone that has been extensively used in Bandon.

A little north of Cork, on the north of the River Lee, the stones in the quarries vary. They are thus described by Wilkinson:—Yellowish-white, close, compact quartz grains, with felspathic cement, and semi-vitreous; also, green, silicious, close, dense, very compact, but with numerous fissures and bedded portions, the latter causing the stone to fail.

Belleview Quarry. Near Cork.—A good and free-working stone; but the workmen prefer the limestone, to which they are accustomed.

Coolconing. Two and a-half miles north of Kinsale.—Yellowish, brown, and discoloured, silicious, open, small imbedded particles of slate; cuts fairly well.

Shippool. Kinsale.—Yellow-shaded green; semi-granular and quartzose; slightly calcareous.

Ballymartel. Kinsale.—Stones varying; best, yellow, fine-grained, compact, but slightly micaceous.

COAL-MEASURES (*Ballinaquila.* South-west of Dromina).—A quarry of good flags, and quarries of sandstone.

LISTS AND NOTES BY A. S. WILLIAMS, BOARD OF WORKS.

(The localities are in the *Devonian* and *Carboniferous*.)

Baltimore. Hill back of Coast-guard Station.—

Light-grey. National school and residence. Fit for any description of work, and improves on exposure. Has been used in some of the ancient structures near this place. (*Vide* page 542. Stones of Sherkin Island and the mainland to the eastward.)

Ballyalley. Seven miles from Skibbereen.—

Grey grit. Coast-guard Station. This stone, if obtained at a reasonable depth from the surface, is fit almost for any sort of work.

Rosscarbery. The Beamish quarries, west of the town.—

Brownish and yellowish. National Schools, Rosscarbery. Good stone for ordinary work, and, if selected, fit for dressings. Can be raised in very large scantling.

Union Hall.—

Blue argillaceous and slaty grit; very hard. Union Hall and Glebe. Only suitable for rubble and walling.

Ballydonegan. Twelve miles west of Bearhaven.—

Brownish. Coast-guard Station. Stone hardens on exposure. Is fit for any description of work.

Lehanemore. Sixteen miles westward of Bearhaven.—

Grey grit. National Schools. Only used in rubble and walling. Very durable, but not fit for chiselling.

Derrincorrin. Seventeen miles north-westward of Bantry.—

Brown. National Schools. Can be raised in fair-sized blocks. Very durable, but not suitable for dressed or chiselled work.

Dromore. Eight miles westward of Drimoleague.—

Grey grit. National Schools. Suitable for building, or can be raised in large dimensions, suitable for flagging. Can be dressed for quoins, and improves on exposure.

Dunnycove Bay. South of Clonakilty.—

Liver coloured. Ardfield National School, six miles from Clonakilty. Used in walling and rubble, window and door-sills of limestone, which is usual in this neighbourhood.

Timoleague.—

Blueish, flaggy grit. National School, Timoleague. Never used except in dressing for opes and sills. It is easily raised in blocks of large scantling; well suited for piers or other harbour works.

Borleigh. Eight miles from Bandon.—

Grey to brownish sandstone. School and residence, Borleigh. This quarry is historical, the stone having been used in the Timoleague Abbey and other ancient structures.

Rahavoon. Six miles from Bandon.—

Brown. National Schools. Very hard ferriferous vein; only fit for walling.

Millstreet.—

Reddish-yellow. Millstreet Dispensary. A superior building stone, suitable for any description of cut-stone purposes; largely used in church work.

Dromagh.—

Grey grit (Coal-measures?). Dromagh[Glebe. An excellent stone, suitable for all dressed work of small scantling, as it cannot be obtained in large dimensions.

Lismore. Six miles from Kanturk.—

Brown. National School and residence. Hard stone; similar stone very common in the county, and used for walling and rubble, the quoins and sills being procured from the Kanturk and Keelin quarries.

Boherbue. Eight miles from Kanturk.—

Brown. Dispensary. Stone similar to that at Lis-
more. Dressings from Kanturk and Keelin quarries.

Inchageela. Quarries in adjoining hills.—

Grey and greenish; flaggy. Inchageela National
School and Kilmichael (Tareton) Glebe. Stone hard; with
difficulty can be chiselled, but is not fit for dressing.

SAND AND GRAVEL.—Good sand for building purposes is procurable in various places in the different valleys. *Pit sand* occurs in the neighbourhood of Cork and Macroom; while good *river sand* is obtained five miles from Bantry, in the River Snaive; in the Lee, three miles from Cork; in various places along the Bandon river and the Blackwater; in the Islin river, near Skibbereen; and in various streams. In numerous places along the coast there is good *sea sand*.

In Bantry and the neighbouring bays there are accumulations of rich *shell sand*, or rather *coralline sand*. Before 1848 there was a large trade in these sands for agricultural purposes, it supporting a large fleet of boats, which dredged the sand, and brought it into Bantry and the other quays, from whence it was carted inland, even over the hills into the Co. Limerick. At the same time there was also a fleet of 35-ton lighters at Youghal, engaged in similar *shell sand* dredging.

Good *pit sand* occurs about a mile from the Blarney Railway Station. It is very generally used in the Co. Cork.

Near Mitchelstown, on the Kingston estate, is excellent *pit sand*; also *river sand* in the River Funcheon.

Near Glanworth, at Dunmahon, very superior *pit sand* occurs on Mr. Dilworth's farm.

At Ballydonegan Bay there is a peculiar sand, due to the crushing of the copper ore. Previous to the Allihies mines being worked, there was no holding-ground for anchors in the bay, and at the mouth of the river there was a gravelly beach. Now there is good holding-ground in the bay and a sandy beach.

For moulding purposes in the foundries the sand is principally procured from Belfast (valley of the Lagan); but some of an inferior quality is got in the neighbourhood of Bishopstown.

GLASS.—In Cork there were two large glass-houses for the manufacture of flint-glass, with extensive premises for cutting, engraving, &c., attached to each. One ceased to exist about 1835, and the other before 1840. The sand used seems to have been imported.

DONEGAL.*

For the most part this county is occupied by granitic, gneissose, and schistose rocks. These, from recent researches, are known to belong to two distinct geological groups, the older probably representing rocks equivalent to the Cambrian and the Arenig, while the later represent the Ordovician and perhaps, in part, the Llandovery or May Hill Sandstone. On these older rocks, in places, such as at Ballymastocker Bay, Fanad; Muff, Lough Foyle; along the mearing of the Co. Fermanagh, to the northward of Pettigoe; and in the neighbourhoods of Killybeg, Donegal, and Ballyshannon, there are Carboniferous rocks of greater or less extent, that in Fanad being a mere patch.

CAMBRIAN AND ARENIG.—The sandstones, grits, and quartz-rocks which occur in the strata supposed to represent these geological groups are now all more or less altered into quartzites, gneiss, and foliated granite. But some of the quartzites, especially some of those in the gneiss and foliated granite, are even-bedded, and, when also regularly jointed, they are excellent material for walls and such like; but they will not bear dressing. Many of the altered quartz-rocks are splintery. In places, however, they are massive, and capable of being raised in large blocks; and, under such circumstances, they are more or less suitable for foundations, sea walls, and other heavy work.

ORDOVICIAN AND LLANDOVERY (?).—The sandstones and quartz-rocks which are supposed to belong to the rocks equivalent to some of these groups are, in a great measure, altered into quartzite. Some, however, are unaltered or very little altered, as sandstones occur in the Rathmullen district, between the ridge called the Devil's Backbone and Lough Swilly; also in the barony of Raphoe, south of Lough and Glen Swilly. In the Rathmullen district some of these stones dress fairly well, but are liable to discolour. Those in Creeve Mountain, about three miles north-

* See "Notes added in the Press."

west of Rathmullen, have been used for facing in Ramelton. In the valley about a mile south of Creeve Mountain, in the townland of *Oughterlinn*, there are flags; these are good, hard, and silicious, and can be raised of large dimensions—12 feet long by a width of 4 to 6 feet. They have been used in Ramelton; but the place is very inaccessible, the road being very bad. To the north of Rathmullen, in places near Lough Swilly, there are also flags that have been worked for local purposes, especially in the neighbourhood of Long Lough.

In the quartzite range of Knockalla some of the quartzites are thin-bedded. They are silicious and hard, and appear as if they could be raised in marketable sizes. These, as yet, have not been opened on; but, if they could be obtained of sufficient sizes, they should be valuable. Up to the present the place has been very inaccessible; but as a pier has been erected in Ballymastockan Bay, at Croaghros, they are now near a port. At the opposite side of Lough Swilly, in Dysertegney, Inishowen, these beds are worked, and produce good flags, that ought to be more utilized than at present.

There are also veins of more or less similar flags in the north of the county, near Crossroad and Dunfanaghy, which are locally used.

[The age of the rocks in the north of Donegal is still undetermined. For some reasons they might be supposed to belong to the later groups, while there are also reasons for supposing they are portions of the older. The geology, however, hereabouts is so complicated, the younger and older strata being folded in sharp inverted curves, that it is quite possible that their exact age will never be satisfactorily known.]

In the barony of Raphoe none of the sandstones have been considered specially suitable for cut-stone purposes, although they are very useful for walls. Those which can be raised in large blocks are good for coarse and heavy work, such as foundations and the like. In a few quarries, however, the stones have been used for dressed work, and they cut fairly well. They, however, are liable to discolour.

Muckish. Three miles from Dunfanaghy.—Quartzite; open and porous; pure white; semi-crystalline; slightly foliated; very slightly calcareous.

Kincleirin. Nearly a mile from Dunfanaghy.—White quartzite, with minute divisions of mica.

Erraroeey. Near Crossroads.—Yellowish; improves in colour on exposure; silicious; durable; free-working; can be plugged, and hammers well; can be raised in long scantling, and is capable of long bearings; was used in the foundations and coping-stones of Myra Bridge and in the Roman Catholic Church and School-house, Crossroads. The vein extends eastward and westward.

Minnagran. Seven miles from Glenties.—Here the rocks are very much altered, and appear to be more of a gneiss than a quartzite. The stone is used for dressed work, and in the vicinity it is called "millstone."

At *Carrick*, eight miles northward of Milford, and in places to the westward, there is a reddish, porous quartzite, that squares fairly well, but will not cut. It is a good building stone, and was largely used in the building of Manorvaughan, or Mulroy House. It keeps its colour, and has a good effect. Locally it is called "red granite."

Killyclug. North of the Letterkenny Waterworks.—Quartzose sandstone; rises in long massive flags; capable of long bearings; good for rough building, such as lintel and posts in farm buildings.

CARBONIFEROUS.—In the already mentioned Carboniferous outlier at Ballymastoker Bay, Fanad, there are red conglomerates and sandstones. The first were formerly used, to a small extent, to be wrought into flax-crushers, while the sandstones were used for local purposes.

In the parish of Muff, on the west of Lough Foyle, and to the north of Derry, the rocks consist principally of reddish sandstones and conglomerates, which are used for local purposes.

To the south-east of the county, margining the Co. Fermanagh, that is, northward of Pettigoe, there are in places stones of yellowish-grey shades. At *Lettercrann*, about three miles from Pettigoe, were procured the stones for the stations on the Enniskillen and Bundoran Railway.

In this tract some of the stones are specially suited for flax-crushers and millstones, and forty or fifty years ago many were made.

In the Carboniferous rocks, near Donegal and Ballyshannon, some of the sandstones are of good characters. They are from pale cream-colour and nearly white to reddish and purplish; from very fine to coarse conglomerates. Formerly from this county

there was a large trade in flax-crushers, they being sent on carts into the other portions of Donegal and the neighbouring counties, or shipped from Donegal town to different places along the coast-line.

This trade seems to have been very short-lived. Formerly flax was kiln-dried, the old disused kilns being scattered over the county. In general, the inhabitants cannot tell you what they were for; a few, however, state that in their grandfather's time, some sixty or seventy years ago, before the stone-crushers were invented, all the flax was "beetled," that is, crushed by hand with wooden beetles, and, before doing so, it had to be kiln-dried. The kiln-drying ceased when the crushers came into fashion; and the trade in the latter appears to have died out some ten or fifteen years ago, partly on account of the failure in the flax crops, partly because mills were erected in which the flax was crushed, and partly because, by some of the new modes of obtaining the fibre, the flax does not require to be crushed, but is sold in the unbroken state. The unsold flax-crushers are to be seen everywhere about the town of Donegal; lying in heaps, as if some giants had been playing a game of quoits. They are now put to innumerable uses.

The stones near *Mount Charles* have lately been greatly brought into notice by the Drumkeelan stone being selected for the new Museum and Library, Leinster House, Dublin. Wilkinson, in 1845, stated that the best stone is yellowish-grey, or pale cream-colour, free, felspathic, slightly micaceous, with a silicious ferri-ferous cement. Of it Mr. Cockburn states:—"It is good and durable, but hard to work; and has been used in the dressing, Town Hall, Sligo; also for quoins and dressing, with other sand-stones, in the Killybegs Coast-Guard Station. The Provincial Bank, Ballyshannon, was contracted to have been built with this stone; but, when half up, the supply of good materials seems to have failed, the upper portion being stones from Dungiven, Co. Londonderry" (see *Dungiven*, p. 281).

Altito. Three miles from Donegal.—Dirty yellow. Varying from granular to conglomeritic; very quartzose; semi-crystalline; hard; cement felspathic. Formerly largely wrought into mill-stones and flax-crushers; also heavy kerbing-stones. Used for ash-lars in Lough Eske Castle.

Drumkeelan. Three miles from Mount Charles Pier.—Creamy, to nearly white; felspathic; slightly micaceous, with slightly calcareous cement. Dresses and cuts well; hardens on exposure. Good strong flags can be obtained here; used in the town of Donegal. Three thousand tons of this stone have lately been shipped by the Messrs. Beckett, to build the Museum and Library for the Science and Art Department, Leinster House, Dublin.

Beauwin.—Used in Killybegs Coast-Guard Station for boat-house and slip. "Coarse and uneven in grain, with large quartz pebbles. There are some beds of a fine texture and a beautiful tint in this place, but there is no regular quarry, the stones being raised off the surface, and where they can be had with least trouble" (J. Cockburn).

Kildoney. Four miles from Ballyshannon.—White, micaceous, silicious grains, with argillaceous silicious cement. This stone dresses and cuts fairly well, and is very durable; used for wall-facing. It is near the sea, and therefore easy of transport, but is not thought as much of as the stones from the Dog's Mountain.

[In this neighbourhood, in the cliff overhanging the sea, is an anthracite, about 7 inches thick. In boring in search of this coal, a sort of emery was struck, 12 feet from the surface.]

Dog's Mountain. Fifteen miles from Ballyshannon.—Light yellow, ferruginous, fine-grained, slightly micaceous; works freely and well. Excellent flagging (was used at the Parish Church, Ballyshannon) can be obtained here.

To the south of Bundoran, in the ridge of Calp sandstone, partly in this, and partly in the adjoining counties, is excellent freestone, which was largely used in the buildings in the town.

SAND AND GRAVEL.—Near the top of the north face of Muckish occurs a very superior silicious sand for glass-making. A little of this at the beginning of the century was shipped to Belfast and Scotland. The place, however, is very inaccessible, and the cost of getting was so great, that it was undersold in the markets by foreign sand.

[£2 a-ton is what it was then sold at. It is coarser-grained than the Belgian sand, but of a better quality. The best Belgian sand at the present time can be delivered in Dublin for 15s. a-ton.]

The Muckish sand occurs as a disintegrated bed in quartzite.

Only the washed and weathered-out crop can be seen and examined. How far it extends into the hill, and its quality when followed in, cannot be known unless a level was driven in on the bed.

[Lewis states there is a similar sand near Lough Salt. This, however, after minute inquiry, I cannot find; it seems to be unknown.]

Kane points out that, "In several of the bays of Donegal the sand thrown up by the Atlantic storms is of great purity, and fully equal to that in ordinary use amongst glass manufacturers."

Donegal sand was used at the Glass Bottle Works, Ringsend, Dublin, "and found very good;" but owing to the price having risen, the use of it was discontinued.

In some of the streams westward and south-east of Letterkenny, there are sands also due to the disintegration of quartzite or sandstone *in situ*. Those known are, however, more or less impregnated with iron.

A rather quartzose sand occurs along the railway from Letterkenny to Derry, at Ballyboe and Monclink. The sand from the latter was largely used as ballast on the line.

Pit sand for mortar in general is not very plentiful; it however occurs in Inishowen and near Milford; while there is inferior *pit sand* in the neighbourhood of Dunfanaghy and Falcarragh. A very good greenish *pit sand* occurs a little north-east of Kilma-crennan. A fine sharp sand occurs in small hills in Tullybeg, east of Lough Fern; while about two miles westward of Rathmelton, in the valley of the Leanane, in small esker-like ridges, there is a clayey sand, used in Ramelton. *River sand* from the streams and rivers is, however, in general good; excellent sand for use in Donegal being found in the Dunmurry and Legacorry streams. Other good *river sands* occur near Glenties; above Letterkenny, in the Swilly; in inexhaustible quantity in the Foyle, south of St. Johnstown, used in Derry; in the Finn river, at Lifford; and in various other places. Good *sea sand* is got in places along the coast-line. There are on the west and north coasts very extensive dunes and tracts of *Æolian sand*.

"Close to the village of Muff, fine sharp white *free sand* occurs; used extensively in the neighbourhood and Derry (six miles distant) for scouring steps and such like. In this neighbourhood some of the sandstones are very soft and friable." (*A. M'C. Stewart.*)

DOWN.

Rocks of Ordovician age occupy the major portion of this county; but in these to the southward, among the Mourne Mountains, in the vicinity of Carlingford Lough, are intrudes of granite and other Exotic rocks. Two very small tracts of *Carboniferous* rocks occur, one on the margin of Carlingford Lough, and the other in the vicinity of Castle-espie, at the north end of Strangford Lough; while to the north-west and north, in the valley of the Lagan, northward of Comber, and in the neighbourhood of Newtownards, are *Triassic*. In the valley of the Lagan, over the Trias, are other Mesozoic rocks, and the *Eocene* (?) dolerytes, with their accompanying basal beds.

ORDOVICIAN.—The various grits that occur in places in the rocks of this group seem to be only used for local purposes, as in the area there is no quarry of note. In the district the slate rocks are usually used for rubble work; and granite, or Trias sandstone, for groins, dressings, and other cut-stone purposes. At Ballygowan there is a stone used in the National School, which Mr. Grey reports as “very hard, durable, and dark-coloured—nearly black.”

Near the “Stone Circle,” Millan Bay, and to the south-west of Slievenagriddle, flags of large size can be obtained.

TRIASSIC.—In the quarries along the valley of the Lagan the stone, nearly invariably, is of a deep-red, or brick-colour, and more or less soft and argillaceous. It has been largely used for local purposes, especially for the bridges of the Ulster (now the Great Northern) Railway. There is a considerable quarry at Kilvarlin, near Moira.

To the north of the county, at *Scrabo Hill*, near Newtownards, there is a better class of stone. Here there are different quarries, in which the stone varies greatly in colour and quality, there being shades of grey, yellow, and red; some are argillaceous, others silicious, while they may be friable, or have concealed joints or vests; therefore they have to be selected with great care if good and uniform work is required.

[Blasting is too prevalent in this quarry. Good stones, with a little extra trouble, might be raised by the crowbar and wedge, while, if raised with powder, they are

shaken, and more or less valueless. This remark is not only applicable here, but also in various other sandstone quarries, where the character of the stone is spoilt by the mode of raising the blocks.]

All the stones are free-working, and, if raised with care, and well-selected, are durable. Formerly they were very extensively used in Belfast, but of late years they have been out by a very general introduction of Scotch stone.

These quarries also supply good strong flags, from 2·5 to 3 in. thick.

Newtownards is built nearly solely from these quarries; the large Town Hall, as pointed out by Wilkinson, displaying some good work.

The Scrabo stones have been used in Belfast, in the Albert Memorial, St. Enoch, Fortwilliam, Sinclair's, Elmwood, and Donegal-street churches; the Academy, in the offices of Robinson and Hewits, and the warehouse of Robinson and Cleaver, the last two being from the *Glebe Quarry*. They were also used in Stormount Castle and the Model School and Strain Church, Newtownards. Mr. William Gray, M.R.I.A., says of the stone, that it is "very variable in colour and texture, stands fairly well when selected and set on bed, but tilted on edge it will not stand. It works freely, and, as a rule, is of a light-brown colour." And of the "*Glebe Quarry*":—"It yields a light-coloured stone, of very even texture, and good colour. It is soft, but stands fairly well, and makes a good building stone.

Dundonald. Four miles from Comber:—Red; fine-grained; like the Dumfries stone (*Scotch*), and has been used for it. The quarry does not yield a very large quantity. Has been used in Belfast in the Spencer basin; cottages and villas at Knock; Preston, Smith & Co.'s Warehouse, &c. (*William Gray*.)

The principal Irish sandstones used in Belfast are from the Scrabo and Dundonald quarries, Co. Down; Dungiven, Co. Londonderry; Ballycastle, Co. Antrim; Cookstown, and different quarries near Dungannon, Co. Tyrone; those from Ranfurly, Mullaganagh, Bloomhill, and Carlan being most preferred.

SAND AND GRAVEL.—Good *pit sand* occurs in the valley of the Bann, also at Saul, between three and four miles from Downpatrick, in the neighbourhood of Newtownards, and in other places. There is good *river sand* in various places along the streams and

rivers; while near Kilkeel and Newry the *sea sand* is also good. Red sand suitable for *foundry purposes*, and exported from Belfast to Dublin, Cork, &c., is procured in the valley of the Lagan.

FLINT-GLASS was formerly largely manufactured in Newry. Although this was in existence in 1840, yet now it seems hard to get information about it.

There was a second manufactory at Ballymacarret, a suburb of Belfast. To this, at the beginning of the century, a few cargoes of Muckish sand—Ards, Co. Donegal—was brought, and found to be very superior; but the expense of getting the sand, and the consequent high price when delivered, drove it out of the market.

DUBLIN.*

There are arenaceous rocks among the *Ordovicians* to the north and south-west of the county, the latter in part being metamorphosed. In the Rathmichael Round Tower, quartz-rock and clay-slate were used; but the masonry is very rude. As beds of limited thickness in the calp division of the *Carboniferous* there are argillaceous sandstones, and there are also sandstones in the Lower Coal-measures.

CARBONIFEROUS.—In some of the calp quarries there are argillaceous calcareous sandstones, or arenaceous limestones, capable of being raised in large blocks, and suitable for heavy work, such as foundations, for which they have been extensively used. In some quarries they are thin-bedded, and give good flags. This was specially the case in one set of beds in the old "Windmill Quarry," Rathgar, and some years ago there was an extensive trade in them. As, however, the "overbaring," and consequently the expenses of the quarry, increased, the trade dropped.

In the north division of the county there are patches of Lower Coal-measure rocks. In these there are some grits and sandstones; but although some of them are fair stones, none of them appear to have been used, except for local purposes.

In the city of Dublin sandstone is largely displayed in the public buildings; but none of the cut stone seems to have been obtained in the county, while most of it, especially in the buildings during the last century, and in the beginning of the present, is

* See "Notes added in the Press."

English stone. Portland stone, according to Wilkinson, was used in the following structures :—Old Parliament House, now called the Bank of Ireland ; Trinity College, except the Provost's House, for which the stone was procured in the neighbourhood of Liverpool ; Royal Exchange ; Post Office ; Rotundo ; King's Inns ; Law Courts ; Custom House ; the dressings at the Castle ; the statue, Nelson's Pillar ; St. George's Church ; St. Thomas's Church ; Roman Catholic Cathedral, Marlborough-street. It has stood well, but is much discoloured. For some years past it has fallen off in demand. Its present price in Dublin is two shillings per cubic foot, and one shilling per square foot for working.

From information procured by Mr. R. Clarke we learn the following as to buildings erected since Wilkinson wrote :—

“Subsequently oolite limestone, or Bathstone, was in demand, which may be here mentioned, although somewhat out of place. At present there are four qualities in the market, which are delivered at two shillings and two pence per cubic foot, and dressed at one shilling per square foot. It has been used in the following offices during the last twenty-five years :—Provincial Bank, College-street ; Guinness's mansion, Stephen's-green ; Standard Life Assurance, Sackville-street ; Trinity Chambers, Dame-street ; Royal Insurance (?), Dame-street ; Crown Life Insurance (?), Dame-street ; Commercial Union Assurance, College-green ; Law Life Insurance, Sackville-street ; and Lancashire Insurance, Sackville-street.

“Caen-stone is used for finer kinds of work than either the Portland or Bath, such as all kinds of inside work.

“Drumfries stone has been used in many of the insurance office buildings.

“Runcorn red was also used in many of the insurance companies' offices as well as in other structures, principally for bands to set off lighter sandstones, or granite. It, however, is not durable, as may be seen in the Augustinian Friary Church, John- and Thomas-streets, where the Runcorn stone has decayed so rapidly, that although only built twelve years, it is now being taken down and replaced by granite.

“Furness Abbey red stone has also been imported.

“Of late red sandstone has been brought from Dundonald, near Comber, Co. Down, and has been largely used in building the new portion of the Great Northern Railway Terminus, Amiens-street.

This stone has a good reputation in Belfast, where it has been largely used."

"Dungannon stone," from Mullaganagh, or the Ranfurly quarry, Co. Tyrone, was used in the new additions to the Royal University, and has held its colour well.

The creamy sandstone from Mount Charles, Co. Donegal, has been used extensively in the new building for the Science and Art Department, Leinster House. This seems to be the first place of note in Dublin where it has been tried.

SAND AND GRAVEL.—In this area, in the ground that is below the two hundred and fifty feet contour line, but more especially below the one hundred feet contour line, there are large accumulations of sand and gravel. In some localities, however, especially those below the lower line, the gravel and sand has extensively been worked out for road and building purposes, large areas being cleared of the accumulations that once existed, so that anyone now mapping the edges of the gravel terraces would draw lines quite different to those of the margins of the original sea-beaches. This is specially the case in the tract between Booterstown and Dublin. As, however, these sands and gravels are so prevalent in the county, good *pit sand* can be procured in numerous places.

The Drift Cliffs of Killiney Bay are for a large part composed of these gravels, and the sands, the washing from the cliffs, have within the last thirty or forty years come into great repute, so much so, that now, almost as fast as the beaches form, they are carted away, to the great detriment of the owners of the adjacent land, as their land, being deprived of its natural protection, is rapidly carried away by the sea. This removal of the sand, and consequent waste of land, has led to various lawsuits.

[Within the last forty years, since the great trade in Killiney gravel has been instituted, the cliffs, from a want of their natural protection, are receding backwards at a rate of at least one foot every year; while, in certain places, the destruction is even much more extensive, exceeding two or even three feet per annum. From careful calculation made on the coast of Wexford, where the natural waste of the drift-cliffs at the present day is greater than elsewhere in Ireland, the average waste is one foot per annum, the excessive waste in two or three other places being three feet per annum, and in one or two as much as four feet and five feet.

These wastes on the coast-line are very interesting, some being evidently due to artificial structures. Thus, the intaking of the north and south slopes in the Slaney lagoon (Wexford Harbour) changed not only the character of the Dodder Bank, at the mouth of the lagoon, but also that of the Lucifer Shoal, six miles off its entrance. And these

changes in the banks have affected the infringement of the currents on the northward coast, so that since these intakes have been made the coast-line of the North Bay, that is between Wexford and Cahore, has been much more rapidly denuded. On the other hand, on the South Bay, or as it is now called on the recent charts, Ballygeary Bay, the erection of the new pier at Ballygeary has quite changed the features of the shores of the bay, by accumulating fulls at the base of the cliffs that previously were rapidly being denuded away. . This is especially the case between Ballygeary Pier and Greenore, where there are now "fulls" and apparently permanent beaches in places that ten years ago showed a clean-washed rock surface up to the base of the drift-cliff; these beach accumulations covering up most interesting geological sections, that probably will never be seen again until Ballygeary Pier has disappeared. On the south coast of Wexford the Ballyteigue flats were intaken; here also the change has had great effect, as since the intake the land immediately west of the entrance to the lagoon has been rapidly denuded away; but further westward, in the vicinity of Cullenstown, a foreshore has grown out. If it were necessary, various other cases could be enumerated where there are also changes due to human agencies. In other places changes are taking place from unknown and hard-to-be-explained natural causes, fulls forming or being cut out for no apparent reason. The most remarkable case that has come under my observation is the tidal effect on the middle island of Arran, at the entrance of Galway Bay, where the effects of the tidal currents of late years are perfectly different to those a quarter of a century ago, while there seems no apparent reason for a change.]

Good *pit sand* for building purposes can be obtained at Knockmore, Valley of Diamonds, and Ballywaltrim, Dargle-road, Bray; also at the Moat, Old Connaught. The last is a very superior sand, very clean and sharp (silicious). It is in Lord Plunket's demesne, and is not for sale, but is used by special permission for any very particular stucco plastering rough-cut work. There is no sand equal to it, certainly none to surpass it, in the Co. Dublin. (*T. B. Grierson.*) The *foundry sand* (red) used in Dublin is imported from Liverpool and Belfast, costing, delivered, about 15s. per ton. At one time good sand came from Co. Cork, but it does not seem to be used now.

GLASS formerly was largely manufactured; but in 1886 there were only two flint glass and seven glass bottle manufacturers. Through Mr. White of Dublin we learn that at the Ringsend Bottle Co.'s works the common bottle glass is "made by the fusion of the following materials: sand, from the adjoining Sandymount strand; blue clay, from Sutton strand; waste lime, from Bewley and Draper's chemical works; kelp waste; broken red tiles, to give body; rock salt, from Drogheda; refuse manganese; a small quantity of coarse fluor-spar, and oyster shells.

"The materials now used for the finer glass are Antwerp sand,

French chalk, carbonate of soda, oxide of manganese, fluor-spar, and arsenic.

"Ground granite was used formerly for the finer varieties of glass, but was discontinued in consequence of the high temperature required for its fusion. Donegal sand was also used, and was found very good; but, owing to the price having risen, the use of it was discontinued."

FERMANAGH.

To the north-west of the county there is a small tract of metamorphic rocks coming in from those of the Co. Donegal. They are probably the equivalent of the *Arenig*, or perhaps *Cambrian*. East of Lower (North) Lough Erne are *Silurian* of the "Lower Old Red Sandstone" type. The rest of the area is occupied by *Carboniferous* rocks.

The age of the Carboniferous rocks occupying the tract at the south-east of the county, of which the highest summits are Slievebeagh (1255 feet) and Carnmore (1034 feet), is disputed. Griffith considered them "*Calp*," or the middle group in the Limestone; John Kelly, whose opinion is adopted by Dr. Hull, calls them *Coal-measures*; while Baily states the fossils prove them to be *Lower Carboniferous*. As previously stated, we believe that they are *Coal-measures*, and will refer to the lower sandstones as "Fermanagh sandstone." (See page 222.)

West of Lower Lough Erne, extending S. S. E. from Lough Erne, past Derrygonnell to the Arney river, is another tract of *Calp*; while north-east of Lower Lough Erne, in the Kish district, the rocks are of the "*Ulster Calp* type," capped to the south-west of Kish by a small tract of "Fermanagh sandstone" (*Lower Coal-measures*).

In the western part of the county are *Coal-measures*, part of the CONNAUGHT COAL-FIELD, which, as previously mentioned, extends into the province of Ulster.

ORDOVICIAN.—The grits of this group can be used for walling and rough purposes; but, as there are usually better stones in the vicinity, they are only very locally used.

SILURIAN.—The sandstones, which are in the majority in the mass, are generally shades of red, brown, and purple, although

some are yellowish or variegated. In many of them there are argillaceous or shale spots and specks. At Lisbellaw, in connexion with the exposure of Ordovicians, a massive conglomerate abruptly comes in, as if it had been a shingle mass against a head, that acted as a groyne at the end of an ancient strand. The pebbles in it are remarkably hard, and are much used for road metal. The evident circumstances under which the "Lisbellaw conglomerate" accumulated have been given in a Paper on this subject (vol. vii., p. 191).

These Silurian sandstones are in general too coarse for dressed work, though well adapted for ordinary or coarse work. The finer kind was extensively used in Necarn Castle, near Irvine—or Lowtherstown—the dressing being the Calp sandstone from Lisnaskea. At Castle Archdall, however, in the same neighbourhood, it was used for the quoins and dressing, while the walling is an impure limestone.

In *Ardlogher Quarry*, near Irvinestown, the stone varies, being shades of reddish-grey. It is granular, semi-crystalline, hard, compact, and slightly calcareous. Lower beds mahogany-red to red; argillaceous; laminated and micaceous; works fairly well.

Mullaghfarm. Four miles from Irvinestown.—Brittle and hard to work; used for quoins and common dressing.

Kerlish. Eleven miles from Irvinestown.—Various; generally coarse, conglomeritic, quartz-grain, felspathic cement, and slightly ferriferous; others finer in texture.

CARBONIFEROUS.—In the disputed area of Slievebeagh district, here described as *Fermanagh sandstone*, there are some noted quarries. In the neighbourhood of Lisnaskea most of the stones are creamy, yellowish, or slightly greyish, good, free-working, and have been extensively used in Lisnaskea, besides other places in this and the neighbouring counties, such as Irvinestown, Enniskillen, Clones, Monaghan, and Newtownbutler. They do not, however, seem to have gone into the Dublin or other distant markets, although some of them are well worthy of notice. Stones from these quarries were used as quoins and dressing at Crom Castle, and at Necarn, near Irvinestown, for ornamental work.

Tannyby. Near Lisnaskea.—Yellowish-white to reddish-grey; finely silicious-grained; felspathic cement; ferriferous spots; free-

working; many houses in Clones and Lisnaskea are built of this stone; but the quarry seems to be now closed.

Slush Hill. Two miles from Lisnaskea.—Greyish-white and yellowish; silicious-grained; scarcely any cement; ferriferous stains; some beds very friable; easily worked. Some fifty years ago this was the principal sandstone used in Enniskillen, Clones, and Lowtherstown (now Irvinestown). Dartry mansion, Co. Monaghan, and Farnham, Co. Cavan, were built of stone procured here. Now, however, the quarry is not worked, on account of the “overbaring.”

Kilturk, or Mount. Between two and three miles from Lisnaskea.—A somewhat similar stone; splits into long scantlings. Nearly all the gate-posts and the cut stones for the buildings of the Great Northern Railway westward of Dundalk were procured from this quarry.

Knocknalossett. Seven miles from Lisnaskea.—The stones for Monaghan College and smaller buildings were procured here.

Crocknagowan. Two miles from Lisnaskea.—Stones used in Presbyterian churches, Belturbet and Aughnamullan, Co. Monaghan, Clones Gas Works, and Tempo House; also wrought into tombstones.

Eshbrally. Three miles from Lisnaskea.—Stones used in Inishmore Hall, and for pillars and dressing in Crom Castle, and in the new work, Enniskillen Church. It is also wrought into tombstones, and some of the beds into scythe stones.

Altnabrock, or Aughnabrock. Near Lisnaskea.—Clean, fine-grained, and massive; Ulster Banks, Enniskillen, Lisnaskea, and Clones; seems to be much sought after at the present time.

Corraghy, or Eldericood. Three miles from Brookborough.—Not in repute for cut-stone purposes.

Carnmore.—Pebbly, silicious sandstone; good; hardens on exposure; easily worked when first raised. This stone formerly was extensively wrought into mill-stones and flax-crushers before these industries declined.

To the north-east of Lough Erne, in the Calp of the “Ulster type” of the Kesh district, there are good stones to be procured in Inishbo (Cow Island) in the north portion of the lake, and in different places north-east of Kesh. According to Mr. Plunkett,

M. R. I. A., the beautifully sculptured cross on Devenish is cut in stone from the latter locality.

[The quarries north and north-east of Kish are in the *Calp* sandstone; while those south-west of Kish are in a small outlier of *Fermanagh sandstone*.]

Good hard silicious stones may be procured in the Derrygonnell Calp area, to the west of Lower Lough Erne—as in the neighbourhood of Church Hill. About Monea they are in general massive, with subordinate flaggy beds. Kerbstones were procured here for the village of Lisbellaw; and in 1800 the town of Enniskillen was paved with setts procured from this neighbourhood (*G. S. M.*).

Some excellent stones have been noted in the COAL-MEASURES to the west of the county. They, however, are far away from any market or town, and are more or less difficult to get at: on which account, and also as good sandstone can be had more conveniently, they are not sought after.

For the following list of quarries, with their distance from Enniskillen, we are indebted to Mr. John Wray, the Borough Engineer:—

Carnmore, 23 miles; parish of Clones; Clones Church and Market-house.

Mount, 15 miles; parish of Galloon; Railway Bridges from Clones to Enniskillen.

Eskbradley, 15 miles; parish of Galloon; Newtownbutler Market-house, Irvinmore Hall.

Aughnabrock, 13 miles; parish of Aughavad; Ulster Bank, Enniskillen.

Stonepark, 14 miles; parish of Kinawley; Derryglin churches.

Leighan, 7 miles; parish of Devenish; Bridges, Lillias river; Kerbs, &c., Enniskillen.

Rossanuremore, 15 miles; parish of Devenish; Bridge and Church, Garrison, Ballyshannon.

Glenashater, 15 miles; parish of Innismacsaint; Bridge between Derrygonnelly and Garrison.

Killroskagh, 14 miles; parish of Cleenish; Belcoo and Holywell Bridges.

Aghnaglack, 12 miles; parish of Boho; Derrygore House, Enniskillen.

The round tower on Devenish, in Lower Lough Erne, is built of local sandstone, and displays good work, with ornamental mouldings at the base of the cone. There is also the very handsome cross that was exhumed when the tower was repaired about 1878. It displays elaborate and careful work. Since it has been placed in its original site it has considerably suffered from the weather. The stone, as already mentioned, seems to have been procured from the Kesh sandstone to the north-east of the lake.

SAND AND GRAVEL.—There is good *pit sand* near Irvinestown. Good *river sand* can be procured in many of the rivers and streams. That used at Lisnaskea is brought about two or three miles, and what is used in Enniskillen is principally brought by boat from the River Arney, and from near Pettigoe. There is also good *river sand* near Irvinestown.

GALWAY.

The rocks north of Galway Bay are more or less granitic, and Professor Hull has stated that he considers that they are of Laurentian age, this opinion being grounded *solely on their lithological characters*. Unfortunately for this theory, although the rocks in the vicinity of Galway are more altered than elsewhere in the county, they graduate northward and westward into rocks only slightly altered, the fossils in which prove their true ages. The slightly altered rocks to the northward are not included in Professor Hull's *Laurentians*, as in them are found fossils of Ordovician type; those, however, are to the westward. In the latter as yet no fossils have been found, but they have not been properly searched. The fossil evidence in the rocks to the northward proves that these so-called Laurentian rocks are some of the youngest of the metamorphic rocks of the Co. Galway.

[It is evident that the time of the metamorphism which gives their present gneissose characters to the rocks was post-Ordovician; also that the granitic and schistose characters of the rocks are solely due to this metamorphic action, and not to the age of the rocks.]

In West Galway the *Ordovicians* appear to have graduated downwards through the *Arenig* into the *Cambrian*, so that all are now more or less represented. In the more altered portions

(*Ordovician*) there are quartzites and quartz rock (*gneissen*), while in the less altered portions to the north and to the westward (the latter classed as *Laurentians*) there are grits.

To the east of the county, in the mountain groups (*Slieve Aughta*), there are also *Ordovician* rocks; they are not, however, metamorphosed. To the north of the county, from the Atlantic eastward to Loughs Mask and Corrib, is a long tract of *Silurian*, while margining the *Slieve Aughta* *Ordovicians*, and in two places on the shores of Lough Corrib—at Oughterard and Cong—are *Carboniferous* sandstones. In the Calp, north-east of Athenry, are calcareo-argillaceous sandstones.

CAMBRIAN (?) , ARENIG, AND ORDOVICIAN.—In general the quartzite and quartz rock are splintery, or break irregularly; in no case are they fit for dressed work. As much better stone can easily be procured, they are rarely used, except for local rough work. Some of the grits in the less altered *Ordovicians* are fair stones.

SILURIAN.—Good stones from fine to coarse conglomerates. Yellowish-greens, browns, and reds; some easily worked, but not in use, as the localities are backward, and there is no demand. Have only been used in local works. When building Maam bridge, although there was excellent and suitable sandstone in the vicinity, Nimmo brought limestone by water from Cong, Co. Mayo, as he considered it cheaper.

CARBONIFEROUS.—Some of the stones are well suited for cut-stone purposes. Those at the mearing of the county, to the west of Mount Shannon, have been already mentioned (*Co. Clare*, p. 237). To the east of the county are other good stones, locally used in Woodford and Portumna.

A little south of Cappagh, and north of Featherstone Lodge, westward of Woodford, there are stones capable of being ground to a smooth surface, and of making flagging similar to the “*Kinnity flags*,” *King’s County* (p. 275).

Benmore. Two miles from Woodford.—A fine freestone; can be raised in large blocks; suitable for all cut-stone purposes.

Slieve Dart. North of Dunmore, to the north of the county, and partly in the Co. Mayo.—The massive pebbly grits were formerly extensively wrought into millstones. In this hill, not very long ago, was raised very extensively a very thin laminated

smooth flag, locally known as *Dunmore slate*. This, in old times, was used for roofing instead of slate, as will be seen on the old houses in Dunmore, Tuam, and the neighbouring towns in the Co. Mayo. It made a good substantial roof, the weight of the "slates" being suitable to the heavy gales and storms of the county. They were not very unsightly; far less so than the "Stourbridge slate," used in Oxford, England. They, however, required heavy timbering to support them.

In the vicinity of Cong and Oughterard, the tracts of Lower Carboniferous Sandstone are of limited extent, and the sandstone is but little used on account of the excellent limestone in such extensive tracts in those localities.

As loose stone in the islands, and along the shores of Lough Corrib, are some peculiar sandstones. They have not been observed *in situ*, and possibly may be of Silurian age; but in appearance they are more like the Carboniferous rocks. In weathering, excrescences like small gooseberries grow out from some, while others become pockmarked, small concave hollows weathering into them. The latter stones, when weathered, are extremely durable, as can be seen in the chancel arch of the ancient church on Inchnagoill, in Lough Corrib. This arch was restored some years ago by the late Sir B. L. Guinness, Bart., the missing stones being supplied by ashlers cut from similar stones picked up along the shore of the island. The old and new stones were so similar, that now, after a lapse of thirty years, it is hard to say which are the new ones.

It is hard to explain the cause of the growing on the surface of the stone of the "gooseberries." We learn, however, from breaking a block that the "pockmarks" are due to small globular secretions of ferrifero-chloritic matter, that rapidly decay even when exposed to the air. After they are gone, the rest of the stone is very durable.

SAND AND GRAVEL. These in this county are interesting as well as useful. In the low country, east of Galway Bay, and extending northward into the adjoining counties, are the Eskers that are found more or less continuously across the central plain of Ireland; and where they occur there is a plentiful supply of good sand for building purposes, and also gravel for road metal. Outside the limits of the plain, good *pit sand* can be obtained at

Knocknacarra, near Barna, three miles west of Galway, and in various places in the hills of Connemara, but more especially in the ridges between Kylemore Lake and the sea. In the West Galway hills there are also in places large accumulations of fine sand, locally called "Rabbit Sand," considerable dunes of it occurring in the valley northward of Lough Inagh.

In connexion with many of the lakes there are considerable accumulations of good sand, that at the east end of Kylemore Lough being remarkable for its size, as apparently it is quite recent. At Lough Cooter, in the south of the county, is silicious sand which, as in the neighbouring county of Clare, already mentioned, is famous for its use in the manufacture of scythe-boards.

In the rivers and streams there are excellent sands, those of the Gort river and neighbouring hills (Slieve Aughta) being superior. In the north of the county there is also sand worthy of note in the Erriff river that flows into the Killary, it being of good quality and silicious, being made up of the detritus of the Silurian sandstones from the adjoining highlands. Some of these sands appear to be suitable for glass purposes, although none of them ever seem to have been so utilized.

The *sea sands* are of importance. Some are very suitable for building purposes; while in many places along the seaboard are tracts or dunes of blown sand (*Æolian drift*) of greater or less extent. All of these are valuable as manure for the boggy land, some eminently so, being very calcareous, containing from fifty to seventy-five per cent. of limy matter. In the north Sound, Galway Bay, there are banks of *sea sand* made up of broken pieces of nullipores. Formerly these were extensively utilized; but they have not been as much sought after since the introduction of artificial manure.

[If the bog-land is impregnated with iron, the bog must be first drained before sand is applied, as otherwise the sand does more harm than good. It changes the iron into a soluble carbonate, in which state it is sucked up into the pores of the plants, where it becomes oxidized, and kills or deteriorates them.]

KERRY.

The geological groups in which sandstones and grits occur are the *Ordovician*, *Llandovery*, *Silurian*, *Devonian*, and *Drift*.

In the Dingle promontory is a narrow tract of Ordovicians,

called by Jukes and Du Noyer the Anascaul beds. Adjoining these are Silurian, the upper group of which has been called the *Dingle beds*, and the lower group the *Smerwick beds*, the typical Silurians occurring between, as other groups. The Smerwick beds are probably in part the equivalents of the Llandovery or May Hill sandstone. These passage beds between the Ordovicians and Silurians are very similar in aspect and composition to the Devonians, or passage beds (*Dingle beds* and *Glengariff grits*) between the Silurian and Carboniferous, they both belonging to the red types, formerly all included in the "Lower Old Red Sandstone."

[The term Old Red Sandstone once included all red or reddish sandy rocks below the Carboniferous limestone; but by degrees, group after group, as geological knowledge increased, were given special names, and separated from it, till eventually the rocks that remained were those that lay between the Carboniferous limestone and the typical Silurian. Now, however, it is learned that of this remainder the upper portion belongs to the Carboniferous and the lower to the Silurian, while the intermediate passage beds are all that remain to be called either *Lower Old Red Sandstone* or *Devonians*. These beds above the Silurians, also those below them (*Mayhill sandstone* or *Llandovery*), are very similar in aspect and composition; so that in places one has been mistaken for the other. This will be referred to hereafter when describing the rocks the counties Mayo, Roscommon, and Sligo.]

To the south-west of the county are the reddish to greenish type of Silurians that have been called *Glengariff grits*. They in part represent the upper portion of the *Dingle beds*, and in part higher strata. These Glengariff grits graduate upwards into the Devonians, and the latter into the Carboniferous. The Carboniferous rocks in this part of Kerry, that is in the neighbourhood of the bay called Kenmare river, are for the most part of the "West Cork type," they, except near Kenmare, being *Carboniferous slate* and *Coomhoola grits*; but at Kenmare there is a small tract of limestone, and lower limestone shale intervening peculiarly.

In the Dingle promontory margining the Silurians, and lying unconformably on them, are Devonians. These evidently are the equivalents of the Devonians to the north and south of Kenmare river, and in the adjoining portion of Cork; but in the south part of Kerry and in Cork the upper portion of the Glengariff grits is present, while in the Dingle promontory it is absent, thus necessitating the Devonian of the Dingle promontory to lie unconformably on the Silurian (*Dingle beds*). In the neighbourhood of Kerry Head there is an isolated tract of Devonians. The Devo-

nians of the Kerry Head district and Slieve Mish graduate upwards, through the Lower Carboniferous Sandstone (*Yellow Sandstone*) and Lower Limestone Shale into limestone, while to the east of the county, on the latter, are the Coal-measures.

[The types here are quite different to those in the Kenmare River Valley, except as mentioned, in the vicinity of Kenmare, where the rocks are allied to those of the north-east.]

The sandstones, especially those in the Devonians and Coal-measures, were much more used in old times than at present, as now limestone is generally preferred for cut-stone purposes. The sandstones of the county were, however, principally used in the early Norman architecture; and, from these ancient structures, as exhibited at Ardferf, and in different other ancient ecclesiastical buildings, they seem capable of making good and durable work.

ORDOVICIAN.—The grits and sandstones of this age are not of much account at the present time, except for local purposes, as the localities in which they occur are more or less inaccessible. Some of the early structures in the area would suggest that they were capable of being used in good and durable work.

LLANDOVERY or PASSAGE BEDS (*Smerwick series*) and SILURIAN.—In the *Smerwick series* there are many excellent stones of reddish, purplish, and brownish colour, none of which are in demand on account of their isolated and inaccessible position. In the groups next above (*Ferriter Cove* and *Croaghmarhin series*) there are some good beds; but in general they do not appear to be eminently suited for cut-stone purposes; but in the highest group, *Dingle beds*, there are some first-class stones, suitable not only for cut-stone purposes, but for all sorts of heavy work, being capable of being raised in blocks of large dimensions. There is, however, only a small market for them, and they seem to be used nearly solely for local purposes. In the county south of Dingle Bay, in Glen, or the valley adjoining St. Finan's Bay, there is the old structure called after that saint. It is a *cloghaun*, or bee-hive house, built of a fine-grained sandstone of the locality (*Glengariff grits*), without mortar. The stones in the interior of the cell were so neatly joined and put together, that when visited some twenty-five years ago they presented a perfectly smooth and even sur-

face, while the joints were so perfect that it was nearly impossible to insert the blade of a knife between them.

Minnard. Seven miles from Dingle.—Red ; very fine ; a good colour ; very durable ; can be raised in large blocks ; was used for ashlar and face-work in the Roman Catholic church, Dingle.

Mr. Deane also mentions “a green stone in the Dingle district, used for building purposes.”

Ventry. — Yellowish-brown ; compact ; not heavy ; easily worked.

Killarney.—Dark-grey ; very silicious ; slightly granular.

Ballycarberry (Iveragh).—Purplish-grey ; very silicious ; slightly micaceous.

DEVONIAN AND CARBONIFEROUS.—These vary from coarse conglomerates to a fine-grained sandstone or grit. They are often flaggy, and for the most part are reddish, purplish, or yellowish in colour. In general they are durable, and many of them can be raised in blocks of greater or less dimensions, being eminently suitable for rough work, such as piers, bridges, and foundations. They are also capable of producing good, sound, fine work, as exemplified in the ancient structures. Rattoo Round Tower, in the Kerry Head district, appears to have been built from a hard quartzose sandstone, procured in the vicinity ; and it displays a cut-stone band round the doorway in good preservation.

In Derryquin Castle, which is principally built of the slate rock of the locality, some of the quoins are, to quote Wilkinson, “of a grey-coloured sandstone resembling pumice-stone, which is soft, and works in any direction, but hardens and becomes very durable on exposure. It is found in a long, narrow vein, adjoining the red sandstone, and occurs near the coast, continuing inland towards the Staigue fort.”

Poulawaddra Wood. Three miles from Tralee.—Red ; soft ; fair-working ; Lord Kenmare’s castle, Killarney ; new Railway Station, and various houses in Tralee.

Tonenane. Three miles from Tralee.—Similar stone to that at Poulawaddra ; used in both of the Roman Catholic Churches, Tralee, and other smaller structures.

There are other smaller quarries in Slieve Mish besides those mentioned. Mr. W. H. Deane, County Surveyor, considers the

sandstones to be easier worked than the limestones, but not as durable.

From near Glenbehy were procured the stones for the ashlar work in Aghadoe, Lord Headly's mansion, near Killarney, built some fifty years ago.

COAL-MEASURES.—As already mentioned, there are excellent stones in places in this area, but now in general superseded by the limestone. At *Barleymount* is a quarry, from which the stone was taken for walling-in Aghadoe mansion.

Armagh. North of Milltown.—A quarry in a good brown stone.

In different places in the "Flagstone series," near the base of the Coal-measures, flags have been raised. They are not, however, as well developed as in the Co. Clare, to the north of the Shannon; while there is nearly invariably a considerable "head" of drift, that makes them expensive to quarry; consequently, they are rarely looked after, it being cheaper to use the "Clare flags." At Ballylongford there are fair flags, with black shale partings, at one time quarried for the general markets; while elsewhere are small quarries, that were opened for local purposes.

SAND AND GRAVEL.—*Pit sand* and *gravel* occur near Kenmare, near Tralee, and in the neighbourhood of Killarney; while good *river sand* is procurable in most of the rivers and streams, especially those having their source in Slieve Mish, which carry down a red, sharp, clear sand, used extensively in Tralee.

In several places on the coast of Tralee Bay is a *sea sand*, which is used in Tralee with the stone saws for cutting blocks.

Æolian sand dunes occur in places along the coast. Formerly the calcareous varieties of these sands, as also the *shell sands* dredged up in the bays and the estuary of the Shannon, were highly valued as manure, especially for boggy land. These used to be carried for great distances inland on horseback, even across the hills into the Co. Limerick.

GLASS.—There seems to be no records of glass being manufactured in this county, although some of the fine sands from the Devonian hills seem well suited for the purpose.

KILDARE.

In this county there are not any sandstones that are now used for cut-stone purposes, while the places in which sandstones occur are of very limited extent.

Stones required for dressed or cut purposes are obtained from the limestone quarries at some distances, or from the granite range in Wicklow or Carlow.

In the ORDOVICIANS to the east margin of the county, and in the small protrudes at the Chair of Kildare and Red Hill, there are some subordinate grits and sandstones; while there are CARBONIFEROUS conglomerates and sandstones margining them in places, and coming in from the Co. Dublin, at the Hill of Lyons, to the southward of Celbridge. At Newtown, some miles west of Maynooth, in an outlying patch of COAL-MEASURES, there are also some subordinate beds of grit.

CARBONIFEROUS.—*Red Hill*, a quarry at the northern end.—Red conglomerate; formerly quarried for millstones.

Hill of Allen.—Grits; formerly extensively quarried for millstones.

Ballindolan. North of Edenderry.—Blackish flags; argillaceous and slightly calcareous; used in Edenderry, King's County.

SAND AND GRAVEL.—These are common everywhere in the low country; but some of the sands require to be washed before being used for building. In places there is a sand with a latent calcareous cement: this, when opened in the pits, stands with a perpendicular wall, which does not weather or slip. This sand is valuable as a manure, and formerly was extensively used.

KILKENNY.

To the south-west, coming in from the Co. Tipperary, and to the south-east, coming in from the Counties Wexford and Waterford, are limited tracts of *Ordovician* (?), in the latter partly altered and associated with granite intrusions; while margining these areas are *Carboniferous Sandstones*. To the north of the county are Coal-measures, part of Slieve-Margy, but now more generally known as the Castlecomer Coal-field.

In this county, as so common elsewhere in Ireland, sandstone formerly was extensively used, but afterwards was superseded by limestone. As pointed out by Wilkinson, the ancient structures testify to the beautiful finished and durable work the stones were capable of producing, as specially exhibited in the exquisite doorway of the church in Killeslin Glen, a little south of the road from Carlow to Castlecomer. According to Wilkinson, the local sandstone was used, and this doorway, as also the doorway of the Round Tower, Timahoe, Queen's County, were "evidently constructed by the same workmen."

The same authority states that the columns, mouldings, and other dressings in Jerpoint Abbey also show what the Carboniferous Sandstones are capable of being put to. Its dressings are of the *Lower Carboniferous Sandstone* from the neighbourhood, and still show the chisel marks after seven hundred years. It is generally believed that the stone was got within a mile of the Abbey, where there are any amount of blocks on the surface.

On the authority of Wyley, it is stated that the sandstone in Jerpoint Abbey was procured in the southern portion of the townland of Ballyhowra. "The stone is very soft, composed of grains of quartz and earthy felspar, with mica to a small amount." "The tradition is that, when the particular beds of stone were reached, they were wrought underground in the form of a tunnel." He considers the stone unfit for outside work. Wyley, in referring to the ruins of an old church half-way between Knocktopher and Newmarket, states that the stone is similar to that used in Jerpoint, but that it may have been procured either in the Knocktopher or Newmarket quarries. (*G. S. M.*)

As mentioned by Mr. Langrish, "Brownstone House," on the left bank of the Nore, between Thomastown and Inistioge, is built of a highly silicious stone of the district, greenish to purplish in colour, hard to cut, but looks very well. Some of the dressings of Inistioge Abbey, founded 1262, are of this stone and of the hard purple conglomerate which shows in Coolnahan Mountain, between Inistioge and Waterford. It is remarkable how shallow the mouldings were in comparison with those cut in the limestone. At Coalcullen, in the Coal-measures, about four miles from Castlecomer, is a stone of a light-brown tint, and easily worked; it was largely used in the restoration of St. Canice's Cathedral,

Kilkenny. A similar stone occurs near Rosenallis, at the foot of Slieve-Bloom. Both are excellent for inside work. The fine-cut stone house of Castletown, near Carrick-on-Suir, built by Archbishop Cox more than one hundred years ago, has the south front of a darkish sandstone, apparently got in the neighbourhood. The Coolnahan conglomerate, above mentioned, rises in large squared blocks, eminently suitable for the coping of quay walls and such like works, as do also the rocks in the glen at Catsrock, near Tory Hill.

Aghavaller Round Tower is built of a brown, slaty-textured grit stone, in irregular courses.

ORDOVICIAN.—The grits and sandstones in this group are almost invariably hard and splintery, not being adapted for cut-stone purposes. They are, however, used for rough local work.

CARBONIFEROUS.—Very excellent stones occur in various places both in the *Lower Carboniferous Sandstone* and in the *Coal-measures*, as just now mentioned. The hill of *Drumdowney* was formerly famous for its millstones, which were said to be equal to the French. They were sent by water to England, Dublin, Cork, Waterford, and elsewhere. Some of the largest were 5 feet in diameter, and 16 inches in the eye. They were shipped with ease on the Barrow, at the base of the hill. The last stones, wrought about 1876, are in Saul's Mills, near the locality. On the same hill there was also a vein of white stone, fit for all cut-stone purposes of small dimensions.

LOWER CARBONIFEROUS SANDSTONE.—*Baunbree*. Near Scagh cross-roads, four miles from Carrick-on-Suir.—Brown, reddish, and yellowish; kind; apparently durable; used in the Roman Catholic church at Tallaghash.

Annefield, or *Tullynacranney*, and *Oldcourt*. Five miles from Carrick-on-Suir.—Yellowish. The stones, except the quoins, which are limestone, for Pilltown New Church were got from Bregaun Hill, near the Annafield plantation.

Drumdowney. Four miles from Waterford.—Red sandstone.

Mr. P. Burtchael, County Surveyor, points out that, although there are now no quarries open, good stone ought to be procurable from the *Lower Carboniferous Sandstones* in the neighbourhood of Thomastown, Jerpoint, Kiltorcan, and Callan, as attested by the ancient ecclesiastical and other structures. At Coolhill, near Kil-

lamery, there are conglomerates suitable for rough work ; while at Kilmaganny there is a nice, durable yellow stone, used for cut-stone purposes in the entrance gate, Rossenarra, and in houses in the village.

In the LOWER COAL-MEASURES at *Shankill*, *Kellymount*, and *Conahy*, are procured the flags known as CARLOW FLAGS, on account of their being carted to that town, and sent from thence by water to the different markets. The Shankill flags were considered the best, and ranged in thickness from 4 inches to half an inch. They could be raised as large as 12 or 14 feet square, but in general from 8 to 10 feet long, and 3 to 4 feet wide. At Kellymount the flags were very similar, but of a lighter colour. At Conahy they were considered inferior. Some of them were so thin, that formerly they were used for roofing. Formerly there was a very extensive trade in these flags ; but as the "clearing" or "baring" increased on the flag strata, so did the expense of getting them, and they were undersold by other flags. Since then the introduction of asphalt and other artificial footways has greatly lessened the demand for all flags here and elsewhere.

In Conahy, as pointed out by Mr. Burtchael, some of the stones have natural dressed surfaces ("edgers"), which show well as quoins or facings, having the appearance of "nice square cut-stone blocks."

Kiltown. Half a mile from Castlecomer.—Yellow and grey ; durable ; easily worked ; used in the Roman Catholic Church and the wing of the Wandesforde mansion, Castlecomer.

Coolcullen. Five miles from Castlecomer, and nine from Carlow.—Yellowish, kind, and works easily. Used in interior work during the restoration of St. Canice's Cathedral, Kilkenny, and recent work at Freshford Church. Mr. Burtchael points out that the carvings of the ancient doorway of Freshford Church are greatly worn and disintegrated, the stone apparently being like the Coolcullen stone.

Red Sandstone from the vicinity was used in Thomastown Abbey for the capitals of the pillars between the nave and side aisle. On them the carved foliage is much weathered, having been for centuries exposed to the elements, although originally under cover. (*J. G. Robertson*.) Mr. Robertson points out that, in St. Canice's Cathedral, Graigue-na-Managh Abbey, Jerpoint

Abbey (?), and Grenan Castle, in this county, the stone is the same as that so largely used in Christ Church, Dublin, and in the Co. Wexford, in St. Mary's New Ross, and in Bannow Church.

SAND AND GRAVEL.—Good *pit* and *river sand* is very general throughout the county.

According to Mr. Langrish, the best sand in Kilkenny is in the valley of the Nore, at the town. There are good banks elsewhere along the river, but near Thomastown it is mixed with clay. The fine sand for the Kilkenny Marble Works is procured out of the Nore at Three Castles, four Irish miles from the town.

Mr. Burtchael points out that excellent *pit sand* was got at the site of the new glebe-house, Piltown, while the adjoining townland is called "Sandpits." Good sand is also to be obtained near Goresbridge, Inisnag, Thomastown, Castlecomer demesne, and Massford; Kiltormer, near Callan; also Ballincreas, about five miles from Waterford, Ballylusky, one mile, Ballida, two miles, and Knockhouse, three miles from Mullinavat or Kilmacow Railway Station; Ballyhahy, between four and five miles from New Ross; and, in fact, very generally over the county.

In a cave at Serville Lodge, one mile from Kilkenny, on the Callan road, is a very fine sand, but quantity very small.

A sand with a calcareous cement was formerly most extensively used as manure; some of the pits are so extensive, that it has been calculated that they have been worked for at least one thousand years. A sand, considered specially good on hilly ground, was known as *Kilmacow sand*, probably from having first been found or used in that neighbourhood.

Along the tidal portions of the Nore and Suir there is a large tract of what is called *manure sand*, which used to be loaded into barges at low water out of the banks. It contains a large percentage of very fine sand, and was good for heavy soils.

KING'S COUNTY.

The principal localities for arenaceous rocks are the *Ordovicians* and overlying *Carboniferous Sandstones* (Upper Old Red) in the portion of Slieve-Bloom that comes into the south-east of this county. To the south of the county, in the vicinity of Moneygall,

coming in from the Co. Tipperary, are small tracts of similar rocks; while at the western margin there are sandstones on the eastern flank of Knocksheegowna, that may extend into this county.

At the present time none of these stones are in demand for cut-stone purposes, although some of them are eminently suitable, and were used in the ancient structures. In the ecclesiastical settlement at Clonmacnoise, although in the limestone district, and close to an excellent stone of that class, sandstones of a thin, flat-bedded character were used in some of the churches, while the old crosses were wrought out of a fine-grained quartzose sandstone. This is interesting, because, although in places such as Cloyne (Co. Cork), Cashel (Co. Tipperary), and elsewhere, the first structures were built of the local sandstone, in the subsequent ones limestone brought from a distance was used.

CARBONIFEROUS.—Kinnity.—In various places more or less near this town, along the north-west flanks of Slieve-Bloom, are small quarries. In some quarries the stones are from 1 to 4 feet thick, and are capable of being easily worked. In other quarries there are flags of a warm yellowish colour, that are excellent for inside work, as they are capable of being finished so finely as to give an even surface, in which the joints are scarcely perceptible. At Gurteen, about nine miles from Roscrea, flags are raised for use in that town; they vary from 1·5 to 3 inches in thickness.

The monument to the Duke of Cumberland in the public square of Birr, or Parsonstown, is of sandstone from the Slieve Bloom district, but whether from bad construction or bad selection of the stone, it does not now give a good appearance.

SAND AND GRAVEL.—The Eskers are numerous in this county, and they supply an unlimited quantity of good sand; also excellent gravel for road metal. The limestone gravel is much used for manure, the best being found in hillocks or at the foot of the hills. This gravel, when burnt in heaps with the paring of the bogs, gives a very rich manure for tillage.

GLASS was formerly extensively manufactured in Birr, or Parsonstown; but when Lewis wrote, in 1837, only the ruins of the glass-house remained.

In 1652 Boate wrote: "Several glass-houses set up in Ireland; none in Dublin or other cities, but all of them in the country;

amongst which the principal was that of Birre, a market town, otherwise called Parsons-town, after one Sir Laurence Parsons. . . . From this place Dublin was furnished with all sorts of window and drinking glasses, and such others as commonly are in use. One part of the materials, viz. the sand, they had out of England; the other, to wit, the ashes, they made in the place, of Ashtree, and used no other. The chiefest difficulty was to get the clay for the pots to melt the materials in; this they had out of the North."

LEITRIM.

At the south-east of the county, margining Longford and Cavan, also in a small exposure near Drumod, are *Ordovicians*, on which reposes the *Lower Carboniferous Sandstone*. A small exposure of *Silurians*, associated with *Lower Carboniferous Sandstone*, occurs near Drumshambo, to the south of Lough Allen: adjoining that lake there is a considerable tract of *Coal-measures*, a portion of the CONNAUGHT COAL-FIELD; while farther northward there is a small outlying patch of similar rocks to the south-west of Lough Melvin. To the west, coming in from the Co. Sligo, is a ridge of metamorphic rocks running north-east to and past Manorhamilton. These rocks have been said to be *Laurentian*, but this is highly improbable (page 517); and for the reasons given when describing the Donegal rocks (page 548), it is probable that they are the equivalents of the *Arenig* or *Cambrian*.

ARENIG (?) OR CAMBRIAN (?).—These rocks consist of green quartzite and other schists. None of the quartzite is suited for cut-stone purposes, but it may be used for flags, in rough work, or for road metal.

ORDOVICIAN.—Some of the grits and sandstones belonging to this group seem not to be suited for cut-stone purposes, but locally they are used for rough work.

SILURIAN.—There is only a very small area occupied by these rocks. Good stone can be procured in quantity in some places, but they are not sought after; they are, however, used for local purposes.

CARBONIFEROUS.—In places, but especially in the south of the county, the strata adjoining the older rocks are reddish or purplish in colour, and range from conglomerates to fine sandstone. Some

beds, however, here and elsewhere are lighter in colour, being grey and yellow.

Greenan. Four miles from Mohill, loose masses of sandstone. Between four and five miles from Mohill there are several quarries in whitish and brownish-yellow stone, from which large blocks can be obtained.

Between Dromod and Drumsna, eastward of the road, are different quarries. Whitish, clean, even-grained, quartzose, thick-bedded; irregularly jointed but very large squared stones can be obtained; it dresses well, but is hard to work. This is not much used; but the ashlar, groins, and sills for the Aughamore Roman Catholic church were obtained here, and have produced sharp and durable work.

Cloonmorris. Between Dromod and Newtownforbes.—School-house, rubble and walling; free-working and durable.

Crummy. North-east of Carrick-on-Shannon.—School-house, rubble and walling; very free-working and durable; dressing from Creeve (limestone), Co. Meath.

Curnagan, Parish of Fenagh.—A quarry once well known for its millstones.

Killea. Seven miles from Manorhamilton.—Stones vary in colour and composition. The best is whitish. Fine-grained, silicious, works freely; large blocks can be obtained. Other beds are greyish, slightly argillaceous or micaceous. The quarry was largely worked, but expensive, on account of a heavy bearing, and the upper stones being deteriorated by stains.

Glenfarn. Nine miles from Manorhamilton.—Greyish-white, coarse-grained, silicious, argillo-silicious cement, works well.

In various localities in the Coal-measure hills there are said to be good stones; but they are difficult of access. In places are seams of thin-bedded sandstone suitable for flagging, the natural surface being quite even, and, as they are hard, they are very durable. The flags from the Arigna Hills have been used in Carrick and Mohill, and those from Glenfarn in Manorhamilton.

SAND AND GRAVEL.—In the country to the eastward of the Shannon the *pit sand* in general is good; but westward of that river, for the most part, it is inferior.

Good *river sand* occurs in different places all over the area, but often in limited quantities.

LIMERICK.

To the east of the county, coming in from Tipperary, are *Ordovician*s, overlaid by *Lower Carboniferous Sandstone*. Also to the south of the county, in Slieve-na-Muck and the Galtees, there are *Ordovician* exposures, with *Lower Carboniferous Sandstone* margining. In the plain of Limerick are a few outlying exposures of the latter rocks; while in places in the limestone, as adjuncts of the subordinate inlying traps, are tuffose sandstones.

To the west of the county are *Coal-measures*, a part of the MUNSTER COAL-FIELD, while small outliers of similar rocks are found at Ballybrood and Slieve-na-Muck.

ORDOVICIAN.—The grits in this group, as elsewhere, are of little value for cut-stone purposes, although useful locally.

CARBONIFEROUS.—These range from a conglomerate to fine sandstone and grit. Although not now much in demand, in places there are superior stones in the *Lower Carboniferous Sandstone*.

DOON.—In this neighbourhood there is specially fine freestone, which at one time was largely shipped to England and other places. The stone is tough, equal to heavy bearings, and can be raised in long scantlings—on which account very suitable for staircases. It was used for the staircases in Clarina and Adare manors.

Glenstal Castle was built of a good whitish stone procured in the neighbourhood of *Morroë*.

St. Oswald's, near Ballingarry, was built with stone procured from *Knockfierna*. Some of the stones in the quarry were easily worked, while other beds were as hard as flint. The house has been built over thirty years, and Captain Wilkinson states the stones seem to have hardened. Stone from near this quarry was used in the Ballingarry Court-house and Church, but not for out-stone purposes. Mr. Horan, County Surveyor, is of opinion that good stone might be got in this hill if a quarry was opened sufficiently. At present the stone is principally used for rubble work. Near *Kilmeady* there are quarries in siliceous grits. In the Slieve-na-Muck range, near Galbally, fair stones might be procured.

At places in the limestone associated with the intruded and bedded igneous rocks are tuffs, that range from massive agglomerates through conglomerates into fine sandstones, often calca-

reous. They are purplish, reddish, and greenish in colour. Where fine-grained they cut easily and well, but are not durable. A green variety, raised out of an adjoining quarry, was extensively used in the building for the new railway station at Limerick.

An agglomerate, that rises in massive, squarish long blocks, was used in the ancient megalithic structures in the neighbourhood of Lough Gur.

In general the COAL-MEASURE grits are very quartzose, and hard to cut or dress, and are not favourably thought of. They have, however, been used in many of the bridges. In places there are excellent flags, similar to those imported from Money Point, Co. Clare. These have, to some extent, been worked in the neighbourhood of Athea, and also at Barna; and the latter were used in Newcastle and Rathkeale. When first raised, they are soft and easily tooled, but afterwards they become very hard. They also occur in the hills near Glin.

SAND AND GRAVEL.—*Pit sand*, occurs in the neighbourhood of Limerick, near Kilmallock, near Rathkeale, and in other places. Good *river sand* can be procured from the Shannon above Limerick, in the Deel river, near Newcastle, and in greater or less quantities in the mountain streams. *Shell sand* for manure was formerly procured from the estuary of the Shannon. There are also in places, at about the 240 feet contour line, accumulations of *gravel* suitable for road purposes.

LONDONDERRY.

The sandstones occur in the *Ordovician*, *Llandovery* (?), *Silurian*, *Carboniferous*, *Triassic*, and *Jurassic* groups. To the south of the county, coming in from the Co. Tyrone, are older rocks, probably the equivalents of the *Arenig* or *Cambrian*, that are metamorphosed into gneiss and schists.

ORDOVICIANS AND LLANDOVERY (?).—These are more or less metamorphosed. Some of the less altered sandstones cut fairly well, but are not in request, as better stone can be procured in the Carboniferous. A peculiar, finely-laminated sandstone (*book* or *leaf sandstone*); is very good for walling purposes, and has been extensively used in the neighbourhood of Derry.

Prehen (Derry).—Bluish; of a slaty nature. Does not stand
2. A. 2

well, except on the beds, as it is liable to peel and to break at the joints. Used in the Public Offices, Diocesan Seminary, Foyle College, Gwynn's Institution, Roman Catholic Cathedral, &c.

SILURIAN.—The rocks belonging to this formation are of the "Lower Old Red" type, being reddish and purplish conglomerates and sandstones. They occur to the west and south-west of Draperstown. They are not a desirable stone.

CARBONIFEROUS.—There are some first-class stones in these rocks, as hereafter mentioned. They have not, however, been as much in demand as they ought to be, on account of the expense of land carriage, which has allowed them to be cut out of the market by stone imported from Scotland.

These stones range from coarse quartzose conglomerates into fine silicious grits and sandstones of yellowish shades. The latter are easily worked when first quarried, and harden on exposure. They are good for both inside and outside work, and in the old buildings, in which they were very generally used, they exhibit their soundness and durability.

Gort-a-hurk, near Maghera.—Creamy-white, with subordinate greenish beds; very silicious, granular, but little cement; does not work freely. The beautifully and elaborately sculptured doorway of Maghera ancient church, wrought out of this stone, proves its eminent durability. It has been used in Magherafelt.

Fullagloon and *Ranaghan*. Three to four miles north-west of Maghera.—Flags, tombstones, door-steps, sills, and scythe-stones procured in different places; principally worked near the road to the south of Ranaghan.

Carnamoney (Moyala river). Four miles south-westward of Maghera.—Grey and yellowish, silicious; easily worked; used for tombstones, sills, quoins, &c.

Drumard. Near Draperstown.—Bluish. This stone, some years ago, was opened on by the Grahams of York-street, Belfast, and was considered by Mr. A. P. Sharpe, of Dublin, to be a first-class stone. At that time, however, on account of backward situation, and the great expense of getting the stone from the quarry to the market, the enterprise had to be abandoned.

At one time the stones from this part of the county were in considerable demand, and were carted to Ballyronan, on Lough Neagh, where they were shipped to Belfast and other places.

Drumquin.—Yellowish, fine-grained, works freely; when raised, very wet, but dries on exposure; not very durable. This stone was formerly much used in Coleraine and Limavady.

Altmover. West of Dungiven.—Various quarries, varying from white and creamy to reddish greenish-grey; semi-crystalline; argillo-silicious cement; some beds with sand holes. Thin-bedded stones used as flagging in Limavady.

From these and other quarries are procured the stones known as the *Dungiven stone*; and in these different quarries special beds must be better than others, as there is a diversity of opinion as to its quality. From a quarry then known as "Ballyhagan" were procured most of the stones for the Bishop of Derry's (Lord Bristol's) palace at Ballyscullion; but the portico was built of Ballycastle (Co. Antrim) stone (page 230). To the north of Dungiven a quarry has been opened of late years, from which a very superior stone is procured.

Of the stone sent to the Belfast district Mr. Grey states: "This is very excellent stone, of light colour, free from iron, very durable, hammers and tools well; works freely for dressings, sills, and quoins, as well as for rubble work. Has been used in Coleraine Church; in Parish Church, Northern Bank, and Presbyterian Church, Kilrea; Protestant Hall, Belfast; and in the Coastguard Stations at Moville and Rathmullen, for quoins, sills, and dressings."

They have also been used in the Diocesan Seminary, Londonderry; in the Lunatic Asylum (*see Gortnagluck List*, Co. Tyrone, page 306); in St. Columb's Cathedral and the Roman Catholic Parochial Hall. The Provincial Bank, Ballyshannon, Co. Donegal, was to have been faced and dressed with Mount Charles stone; but, when it was half up, the supply seems to have failed, and the cut-stone in the upper portion is from Dungiven. Of the latter *Mr. J. Cockburn* writes: "The stones seem to have been carefully selected, as they are better than most specimens of it to be seen elsewhere in evenness of texture, firmness, uniformity of colour, and freedom from sand holes." They have been used for steps and dressings in different private residences in north-east Donegal.

Glenconway. Eight miles from Limavady.—Yellowish; easily worked; has been used in Limavady, Londonderry, and elsewhere.

Walk Mills. Three miles east and south-east of Limavady.—Brownish and reddish flags, from 3 to 5 inches thick.

TRIASSIC.—Reddish and orange; locally called “Red Free;” very easily worked, but friable, and in general not durable; used locally.

JURASSIC.—Thin-bedded sandstones occur as subordinate layers in the band of Lias that margins in places the Cainozoic plateau of Antrim dolomite. They have been used as flagging, but are soft, and liable to get damp. Formerly they were in great request as scythe stones, a considerable trade in them having been carried on at Magilligan.

CRETACEOUS AND EOCENE.—The arenaceous adjuncts of these rocks are the FLINTS and AGATES, the latter occurring principally in the lower *Eocene Conglomerate*. Anciently they were wrought into war implements. They have been previously mentioned in the description of the Co. Antrim (page 232).

SAND AND GRAVEL.—Good *pit sand*, if well selected, can be procured near Coleraine, and Magherafelt, in Bishop’s Demesne, Derry, and in the vicinity. Good *river sand* is found near Derry and near Newtownlimavady, being very good along the River Roe.

A fair quality of *sea sand* is procured from the sand-banks at Magilligan.

In Londonderry, in 1820, a glass manufactory was established in the old sugar refinery, Sugar-house-lane, but was closed after a few years. It is not now known where they got their sand.

LONGFORD.

To the north of the county, coming in from Leitrim and Cavan, are *Ordovician*s, which are margined by *Lower Carboniferous Sandstones*. At Granard, however, there are peculiarities, the sandstones being interstratified with the limestones. In the neighbourhood of Longford also, south-west of Ardagh, there are outlying exposures of *Ordovician*s associated with more or less marginal belts of *Carboniferous Sandstone*; while in the *Calp* there are also arenaceous rocks, some of which will be mentioned.

ORDOVICIAN.—Here, as elsewhere, the grits and sandstones do not seem to be known, except locally, as none of them appear to be eminently suited for cut-stone purposes.

CARBONIFEROUS.—These rocks, although of small extent, are locally in fair request, notwithstanding that excellent limestone can be easily obtained in the neighbouring counties; and, as mentioned in the previous Paper, the latter class of stone for some years has been principally sought after for cut-stone purposes.

In the Granard district, in general, the stones are whitish-grey or bluish, splintery, and hard to work, and are seldom used, except for walls. There is, however, in some beds, a better class of stone, of a yellowish colour, that works freely.

Ballinacrow. Two miles from Granard.—Yellowish; quartz grains, little cement, micaceous; spotted with iron and calcareous matter.

Dalystown. Four miles from Granard.—Steel-grey; hard, silicious; spotted with calcareous matter.

Ballinamuck. Twelve miles from Granard.—Yellowish; coarsely granular, white grains in an argillo-silicious cement. Here are also to be obtained hard flags of good sizes, that have been used in Longford.

Ardagh.—Greyish-white; open and porous, white grains in a silicio-calcareous cement; ferruginous spots; used in Granard.

Glack. Near Longford.—Over a large tract of country there is a coarse conglomerate. On this conglomerate, in the quarries near Longford, there are sandstones. The latter are yellowish, but becoming white on exposure; coarse, white quartz grains, with yellowish argillo-silicious cement; can be raised in blocks, 6 feet square, and 4 feet thick; used for the buildings in the town, and also wrought into millstones for oat bruising.

Edgeworthstown.—In the Calpy limestone are good flags, very similar in appearance to the Carlow flags.

SANDS AND GRAVELS.—Pit sands procured near Granard, Ballymahon, and Newcastle; elsewhere scarce.

LOUTH.

The major portion of the county is occupied by *Ordovicians*. To the north, at Carlingford, and on the south-east flanks of Slieve-Foye, are small thicknesses of *Carboniferous Sandstone*, and also to the westward, near Ardee.

In the **ORDOVICIANS** there does not appear to be any quarry of

much note, although in various places there are quarries. When of fair sizes, they are worked for local purposes. Although the stones are hard, some of them dress fairly well.

CARBONIFEROUS.—According to Traill, the sandstones near Carlingford are not of much value. (*G. S. M.*)

Kilpatrick. Near Ardee.—Grey, weathering pale-brown, calcareous cement; used for building purposes. Similar rocks are exposed in the bog, two miles N. N. W. of Ardee. (*G. S. M.*)

In the celebrated ecclesiastical ruins of Mellifont and Monasterboice the sandstone dressing used, according to Wilkinson, seems to be Carboniferous Sandstone from the Co. Meath. They and the two large crosses at the latter place are in good preservation, except some badly-selected micaceous stones. In St. John's Gate, Drogheda, the unequal weathering of sandstone and limestone is illustrated. Where the sandstone came from is not known.

[Mr. Sharpe, the well-known Dublin builder, who has carefully traced up the sandstones in some of the ancient buildings, is of the opinion, as already mentioned (*Introduction*, page 510), that the stones at Mellifont are from Doulting, near Glastonbury.]

SAND AND GRAVEL.—Good pit sand occurs near Ardee, and a loamy sand near Dundalk.

River sand is obtained in the Boyne, at Oldbridge, for use in Drogheda.

On the coast are dunes and tracts of *Æolian* sands, at one time in request as an agent for making the stiff clays of the county friable. They seem now to be very little used; they ought, however, to be valuable fertilizers.

MAYO.

To the south of Clew Bay are metamorphic rocks, with subordinate intrudes of granite. These, to the south and eastward, are overlaid by *Silurian* or *Carboniferous* rocks. North of Clew Bay, occupying the north-west portion of the country, and extending in a narrow tract eastward by Westport and Castlebar across the county into the Co. Sligo, there are also metamorphic rocks and granites, which are overlaid either by *Silurian* or *Carboniferous*.

Of the metamorphic rocks in the east and north-west portions of the county it has been stated that they are of *Laurentian* age;

but, as already pointed out, this is highly improbable, if not impossible. Some of them, undoubtedly, are the equivalents of the *Ordovicians*, and the rest are probably the equivalents of the *Arenig*, or possibly part of the *Cambrian*. North of Balla, to the eastward of Castlebar, is a small outlying mass of *Coal-measures*.

CAMBRIAN, OR ARENIG.—These, as just now mentioned, are, for the most part, metamorphosed into schist, gneiss, or granite. There are, however, some quartzytes and quartz-rock, capable of being raised in large blocks suitable for rough work; but they are seldom used, as other stones, as easily procured, are preferred. They can also be utilized as road metal.

ORDOVICIAN.—These, like the older rocks, are in general metamorphosed; but in places, more especially to the eastward, north of the eastern continuation of the Erriff valley, they are not. In the unaltered portions there are some very massive grits and sandstones that would be valuable for piers, foundations, and such rough massive work, but that they are backward and very inaccessible. There is also a pebbly quartzite, very suitable for piers; but it does not appear to have been much utilized.

Between Foxford and Swinford are flags of great dimensions. Symes considered that they are due to water freezing in the joints that split off huge plates, some as large as the side of an ordinary cabin. They might be more utilized than they are.

In the north-west of the county (Erris), "between *Benmore* and *Belderg Harbour*, also along the coast of *Broad Haven*, between *Dawish Cellar* and *Blind Harbour*, flaggy quartzites, in unlimited quantities, light-browns and greys, may be had of any sizes and thicknesses; these are well suited for street flagging, and some beds are easily and cheaply wrought into paving setts. The flags between *Dawish Cellar* and *Blind Harbour* could be shipped from either *Gubatnockan* or *Belmullet*, and those of *Benmore* from *Belderg*. It is proposed to join the latter quarries by a tramway to the harbour and erect a pier there."—(*A. M. Henry*.)

SILURIAN.—These rocks are both of the ordinary and "Old Red Sandstone" types, the latter predominating, and consisting, for the most part, of purplish or reddish conglomerates and sandstones, while the others are principally shades of grey, blue, and green argillaceous rock, in which are grits and sandstones. In one tract, east and south-east of *Louisburgh*, they are in part meta-

morphosed. Some of the purplish sandstones and conglomeritic rocks can be raised in large blocks, and would be suitable for out-stone purposes; but, on account of the facilities for procuring excellent limestone, they, in modern times, have been rarely thought of, except near Newport, where some of them have come into favour. In 1845, Wilkinson thus writes of the sandstone then in favour in that town:—"It varies from a conglomerate or coarse-grained sandstone to a very hard red and brown and whitish-coloured grit. This stone is now generally used for all purposes, and is quarried within a mile of the town on the east. The bridge of Newport has the spandril erected with a fine red-coloured grit obtained from the neighbouring mountains."

[In this neighbourhood the Silurians of the "Old Red type" and the Lower Carboniferous Sandstones are rather mixed, being often very similar in colour and texture, so that, except from personal examination in the quarry, one cannot be distinguished from the other. Most, if not all, of the sandstones mentioned by Wilkinson as used in Newport seem to have come from the tract of Silurians a little eastward of the town; but some of them may possibly have been obtained from the Lower Carboniferous Sandstones of the vicinity.]

To the east of the county, between Charlestown and Ballaghaderreen, there is a tract of Silurians. In this the rocks above and below are of the "Old Red Sandstone" type, while between, are green sandstones, with subordinate calcareous and shaly beds that contain Silurian or Llandovery fossils.

[The green sandstones are peculiar, because, except in colour, they are identical in composition with the rocks above and below them. The fossils occur in three horizons. Those below are of Llandovery types; the middle beds contain fossils of Wenlock types, while in the upper beds they are again of Llandovery types. This, therefore, is an example of the places in which fossils typical of English groups cannot be taken as a positive indication of age;—these rocks, as suggested by Griffith, Jukes, and Foot, are probably in part the equivalents of the "Dingle beds" and the "Glengarriff grits" of the counties of Cork and Kerry: that is, the upper beds of the Silurian closely allied to the Devonians or the *Passage Beds* between the Silurian and the Carboniferous.]

In both the rocks of the reddish and greenish types are some good workable stones, that have been extensively used for building purposes, both in Ballaghaderreen and Charlestown. Some of them seem to be capable of producing good dressed work; but, as they have been principally used in rough walling, their capacities

have not been fairly tested; more especially as only the surface stones have been used in these buildings.

CARBONIFEROUS.—For the most part these occur as bands margining the older rocks, but in places in the limestone they are interstratified; some of them are fit for all cut-stone purposes, although none of them have come very prominently forward on account of the good-class limestone of the county, which is preferred by the workmen.

Meelick. Near Killala.—Brownish grey; quartz-grained, with little cement; easily worked, large blocks can be procured; extensively used in the piers and quay-wall at Ballina, and in the neighbourhood.

Crossmolina. A good freestone to the westward of the Deel river.

Between Foxford and Swinford are flags, some so thin that formerly they were used for roofing instead of slates.

Farm quarry. At Westport there is a peculiar stone. It occurs in the upper beds of the limestone quarry. It is thin-bedded and square, on account of the systems of joints that cut across it, these joint-lines being glazed with a film of quartz. One system of the joints is perpendicular, the other slightly oblique; but if the stones are properly selected and laid, the natural faces produce a perfectly even perpendicular wall, having a surface that looks like finely-cut limestone, laid in narrow courses; they were used in Lord Sligo's house at Westport, the dressings and other cut-stone being of limestone.

In the new church at Westport, Carboniferous Sandstones were used; but, unfortunately, dry stones and newly-quarried stones were mixed promiscuously, and consequently the drying and shrinkage of the latter have caused ugly open joints and uneven settlements.

The old church and round tower at *Aughagower* were built of the local red stone. It seems to have worked freely and well, but is not very durable.

Poulsharavogen. Six miles from Swinford.—This stone, although at the east of the county, is in general similar to that described as occurring at Meelick, near Ballina. In places, however, the stone is conglomeritic or pebbly; and, under such circumstances, Wilkinson considered it better adapted for cut-stone purposes. This

stone has been very generally used in Swinford, Claremorris, and the neighbourhood, and of it was built the round tower of Meelick, south of Swinford (not the Meelick previously mentioned, near Killala), of which the stones are now in good preservation.

Stones that have been used for flagging are recorded as follows:—Thin-bedded sandstones at *Carrickryne*, *Ballycastle*, *Meelick*, and *Carns*; used in Ballina. *Glenisland*, soft when quarried, but afterwards hardening; used in Castlebar; *Gormancladdy*, *Killedan*, *Balla*, and *Carroucastle*; used in Swinford; and *Curveigh*, for use in Westport. There is a very thin, smooth flag, called “Dunmore slate,” raised principally in the Lower Carboniferous Sandstone of Slieve-Dart, near Dunmore, partly in counties of Mayo and Galway. These, in old times, were extensively used in place of slate, as will be seen on the old houses in Castlebar, Crossmolina, Ballinrobe, and other places. This “slate” has been previously mentioned in the county Galway. Besides Slieve-Dart, it also occurs in some of the other localities for Lower Carboniferous Sandstone, as between Foxford and Swinford, but was not as extensively worked as in Slieve-Dart.

SAND AND GRAVEL.—Good *pit sand* for building purposes can generally be easily obtained in the low country; the Eskers in the “Plains of Mayo” affording not only that, but good sand for *manure*, and *gravel* for road metal. The *river sands* are also good; they occur in various places along the rivers and streams. There is also *sea sand* in different places; near Ballina there is a considerable supply.

On the west coast of the barony of Murrisk there are *Æolian sands*, some parts of which are in cultivation and yield good crops, especially potatoes. There are also extensive tracts near Blacksod Bay, and smaller ones near Broadhaven; these seem to have been extensively cultivated formerly for potatoes and barley, but not so much of late years.

A good *glass sand* occurs near Belmullet, which has been used a little for glass manufacture.

MEATH.

To the east of the county, near Balbriggan, coming in from the county Dublin, to the north-east coming in from Louth, and to the north-west coming in from Cavan are *Ordovicians*—the last two being connected by the strip of similar rocks in which Kells is situated. In general sandstones are not exposed at the base of the *Carboniferous*, and in places there appears to be no room for them; they, however, appear near Oldcastle, to the westward of Kells, and between Navan and Drogheda; while Mr. Cruise states there is a small patch of conglomerate on the *Ordovicians* at Stramullen, at the meeting of the Co. Dublin to the west of Balbriggan. Elsewhere beds of sandstone have been observed interstratified with the limestone.

On the Carboniferous Limestone to the north, near Nobber, between Drogheda, Navan, and Maynooth, and near Trim, are outlying patches of *Coal-measures* in which are fair stones. At the extreme north of the county, near Kingscourt, there is a small tract of *Trias*.

ORDOVICIAN.—None of the sandstones or grits of this age seem to have been, or are at present, in favour for cut-stone purposes, nor have they been much used for general work, as the associated slate rocks, except in the tract near Balbriggan, are eminently suited for such work, and in old times and subsequently were, and are, much used.

CARBONIFEROUS.—In the small patches of Lower Carboniferous Sandstone, near Oldcastle and westward of Kells, there are sandstones of reddish, brownish, and yellowish shades of colour. These were used as quoins in the old church of Kells, while the round tower was nearly entirely built of them. They are not very durable, but are of an even texture, and have weathered evenly. Between Navan and Drogheda, along the margin of the Carboniferous rocks very similar stones have been quarried in places. They vary a little in colour; some are streaky or variegated, while they may be argillaceous or quartzose, some being very hard. They are not a good class of stone, yet they are very generally used, and the Round Tower of Donaghmore was built of them. Here, as also in the localities to the westward, some beds are capable of

being wrought into flags, and these have been used in Kells and elsewhere.

Hayestown. Fourteen miles from Kells.—Brownish to yellowish; quartz grains; calcario-silicious cement; not very durable; works easily.

To the north-west of Navan there are some sandstone quarries locally used.

In the tracts of Coal-measures there are some good stones reported; but if local use is ignored, none of them have been worked except in the Nobber district, and there only sparingly, as the bad roads and accommodation make the quarries difficult of access. Some of the thin-bedded sandstones, as near Garristown, make good and strong flags; English flags, however, being easily and cheaply obtained, seem to have prevented their being much worked.

Cortubber. Near Kingscourt; greyish-white; quartz grains; very little felspathic cement; finely granular; works freely and well.

Carricklick. Seven miles south of Carrickmacross. Greyish-white, but unevenly coloured; silicious grains; very little cement; fine-grained; works freely and well; large blocks can be procured. Lough Fea House was built of this stone; used extensively in Carrickmacross. A limited quantity of flags can be raised here, which can be manufactured into hearth-stones.

TRIAS.—The “Red Free” of this area seems to have been very little used, and only locally.

SAND AND GRAVEL.—*Pit sand*, excellent for building purposes; is very general; although sometimes it is loamy. In the cutting for the Meath Railway an inexhaustible supply of sand and gravel suited for road purposes is exposed; some of it is good *manure sand*, but is not much used, so much of the county being under grass.

MONAGHAN.

Occupying all the central portion of the county are similar *Ordovician*s to those that have been described in Armagh and Cavan, which lie respectively to the north-east and south-west. Here, as in those counties, the grits are very little used, the

associated slate being much preferred for general purposes; although not capable of being used in dressed work. Fair flags have been raised in a few places, as in Dartree, which lies north and north-west of Clones.

To the south of the county, in the neighbourhood of Carrickmacross, is a small tract of *Carboniferous* rocks, principally limestone: this is overlaid by *Coal-measures*, and the latter, unconformably, by *Triassic* rock; the principal portions, however, of the outlier of the later rocks are situated in the neighbouring counties of Cavan and Meath.

To the north of the county there is a second area of *Carboniferous limestone*. And margining this to the southward, and lying on the Ordovician, is a narrow tract of *Lower Carboniferous Sandstone*, on which Clones and Monaghan are situated; while further northward are the rocks of the "FERMANAGH SERIES," or *Lower Coal-measures* of the Fermanagh type (*Fermanagh*, p. 258).

In the Fermanagh portion of the Slieve-Beagh district there are different quarries of former and present note; but eastward in this county there are none, although the "Fermanagh Sandstones" extend into it; also in places on the flanks of Carnmore superior stone have been procured. In Castleblayney, Monaghan, and Clones, most of the stones used for cut-stone purposes were brought from the quarries in the Fermanagh portion of Carnmore or quarries in the Lisnaskea district, or from the Clogher district (*Lower Carboniferous Sandstone*), Co. Tyrone. In the south of the county, at Carrickmacross and its neighbourhood, the sandstones have been brought from *Carrickleek*, Co. Meath.

Carnmore.—Yellowish-reddish. Chiefly quartz grains; ferri-ferous spots; somewhat friable; works freely. On the summit of the mountain there was an extensive quarry for millstones; which, after being wrought in the quarry, were let roll down the mountain, and conveyed to Scotstown, where there was a dépôt. On the northern side of the hill there is a soft whitish freestone, and on the southern a hard reddish grit.

Knocknatally.—A good freestone, formerly extensively quarried for use in the neighbourhood.

Emyvale. Southward of.—*Fermanagh Sandstone* (?), used in Monaghan.

In the parish of Donagh, to the north of Monaghan, excellent

freestone was formerly quarried in different places, and the great entrance to Caledon House was constructed of this stone.

SAND AND GRAVEL.—*Pit sand* of a good quality is very general in the county, while *river sand* can be obtained in the rivers and streams. *Gravel* can be procured from the Eskers: those in the Tehallan district being noted for their wearing qualities, they for the most part being made up of hard jaspery pebbles.

[In the high level portions of the counties Monaghan, Tyrone, Fermanagh, &c., there are gravel ridges that have been called "Eskers"; they are not, however, true Eskers similar to those of the great central plain of Ireland. The true Eskers are of marine origin, the ridges being due to the colliding of tidal currents, and all occur below fixed levels, which are the maximum heights of the Esker Sea; their height varying a little, as in the seas of the present day, the tides rising higher in the bays than in the open. The gravel ridges of the high levels, and in some places even on the lower levels, of the above-named counties, are for the most part of a different origin, being similar in aspects to the sands, gravels, and other drifts found in the valleys and plains and slopes associated with the Alpine regions, such as those found in connexion with the "Foot Hill" of the Canadian Rockies. In some of the low counties, Monaghan and Fermanagh, &c., the marine and glacial gravels seem in part to be mixed or to graduate into one another.]

QUEEN'S COUNTY.

The greater portion of this area is occupied by *Carboniferous Limestone*; but to the north-west, surrounding small exposures of *Ordovicians*, are tracts of *Lower Carboniferous Sandstone*; while to the south-east, in Cullinagh and the northern portion of Slieve-margy (LEINSTER COAL-FIELD) are *Coal-measures*. The *Ordovician grits* are rarely used, even for local purposes, the associated slates being preferred.

LOWER CARBONIFEROUS SANDSTONE.—In colour these are from whitish-yellowish to brownish, and streaked. Some are argillaceous, they not being as durable as those having a silicious cement. These sandstones have been very generally used in the neighbourhood. They have been largely used in Mountmellick, a soft, silicious stone in that neighbourhood being at one time extensively manufactured into chimney-pieces and hearthstones. In the churches of Abbeyleix, Slieve-Bloom sandstone and Ballyullen limestone were used in the dressings. Ballyfin House and the chief entrance lodge in the Slieve-Bloom district were built of local

stone; in the latter are some hastily selected, which have stood badly. At *Clonaslee* and *Rosenallis* there is a thin-bedded stone, very extensively used in the county for flagging; they cannot be obtained of large sizes, but are very dry; when first raised they are soft, but rapidly harden. Stones for cut work can also be procured; but, on account of the ungainly shapes of the blocks, are expensive to dress.

Clara Hill, Clonaslee.—Yellowish; very silicious; fine-grained; micaceous; ferriferous spots.

Tinahinch. Three miles from Clonaslee. — Greenish-white; silicious-grained; argillaceous cement; partially carbonaceous matter.

Glenbarrow. Three miles from Clonaslee. — Grey; silicious-grained; ferriferous spots.

Rosenallis Mountain. — Westward of Mountmellick. Very similar to the Clara Hill stone.

Ballysally. Ten miles from Roscrea, where it has been much used. — Yellowish to lightish-brown. Is soft when raised, but hardens on exposure. Works easily.

COAL-MEASURES.—In general, these stones are not now looked after, yet that they are capable of good work can be seen in the previously-mentioned doorway of Killeshin Church, Co. Carlow (page 235). In some of the ancient buildings a thin-bedded grit has been used, also in latter years at Cloggrennan. As those used at Cloggrennan were not suited for cut-stone purposes, other material was used for the dressings.

Cloggrennan.—Dark-greenish grey; fine-grained; close; dense; flaggy; not good for out work.

Corgee and Hollypark. In the Collieries. — Good strong flags were formerly rather largely worked. These flags, on an average, could be raised 12 feet square, the largest raised being 22 feet long and 12 feet wide (*G. S. M.*)

Derryfore. East of Abbeylax. — Olive, thick sandstones and flags.

SAND AND GRAVEL.—Both of excellent quality occur plentifully in the Eakers. In some of the streams coming down from both the Lower Carboniferous Sandstone and Coal-measure hills there are sharp silicious sands.

ROSCOMMON.

To the north and south-west of Lough Allen are *Coal-measures*—a small portion of the CONNAUGHT COAL-FIELD. To the southward of these, extending from the north-west margin of the county eastward, past Lough Key nearly to the Shannon, are *Silurian* of the “Old Red Sandstone” type, which are margined southward and eastward by *Lower Carboniferous Sandstones*. To the west of the county, both north-east and west of Castlereagh, and farther south-west in Slieve-Dart, are patches of similar rocks, as also south-west of Roscommon; while to the north-east of the same town, in a south-west and north-east direction, is Slieve-Baun, near which small exposures of *Ordovician* are margined by *Lower Carboniferous Sandstone*.

The ORDOVICIAN grits, which are of small dimensions, are more or less inaccessible, and are very little used, even locally.

SILURIAN.—These occur in the Curlew Mountains. Of these there is a great thickness, and some of them are fair working stones; but in general they are hard, gritty, and of bad working quality and colour. They are not in request, as limestone is preferred; and if sandstone is required, those belonging to the Lower Carboniferous Sandstone are used.

Associated with these sandstones are felspathic tuffs. Although these are more of the nature of argillaceous than arenaceous rocks, they ought here to be mentioned, as in places the one graduates into the other. Some seem as if they would cut well; but as they are in general in somewhat inaccessible or inconvenient places, they have only been used for farm purposes.

LOWER CARBONIFEROUS SANDSTONE.—In the different exposures of these rocks there are stones of more or less note. At Tarmon, near Boyle, there is a bluish-grey stone, hard and compact; but, on account of the numerous joints, it is incapable of being raised in large lengths. The strata varies from 10 to 24 inches in thickness; it has been used in many of the buildings in Boyle, but is more suitable for rubble than cut-stone purposes.

St. John's Hole. An historical quarry.—This lies north of the river near Boyle. Greyish; good, but hard; has been used extensively in Boyle and the neighbourhood, as in the bridge and

other public and private buildings. According to Wilkinson, it was also used in the old house of Rockingham that was burnt down some years ago; the new house, built in 1863 and 1864, is of limestone from Ballinafad, Co. Sligo.

In the bed of the river adjoining "St. John's Hole" is said to have been situated the quarry from which the stones were procured to build Boyle Abbey. Of this ancient structure, Wilkinson writes:—"Excellent work of every kind, from common dressed stones to carved mouldings and ornaments, and its lofty arches display a skill in construction far superior to the present day. The stone has resisted exposure to the weather well, some of the marks of the tools being still visible." Further, he states in reference to the site of the old quarry:—"It is likely that by well-directed efforts the bed of the river was temporarily diverted in order to get at stone which, from being constantly saturated, had not become so hard as that which was comparatively in a dry position."

[This raising of stones out of the bed of a river or stream seems to have been not uncommon with the early builders, as in different places holes are pointed out so situated, which tradition states were quarries where the stones were procured for adjoining structures. Besides other places, such is the case in the river at Drombogue, in the parish of Kilmacrenan, Co. Donegal, as from an excavation in the bed of the stream it is said the stones to build the adjacent Abbey of Douglas have been procured. A few years ago, during a dry summer, this hole was pumped out, and a rude set of steps were found from the surface to the bottom.]

In this county, as is so common elsewhere at the present time, the masons prefer the limestone for cut-stone purposes, so that the sandstone is in general only used for walling and rubble work, as it is easily roughly squared; in some cases it is used for quoins, window-sills, steps, and such like, while from St. John's Hole can also be procured excellent flags, with a natural smooth surface, of large sizes, and from 5 to 6 inches thick. They, however, are expensive and difficult to get at, on account of the necessary pumping to keep the quarry dry.

Felton. Near Boyle.—Yellowish; micaceous; ferriferous.

French Park. Within a mile of the town.—A silicious sandstone, used for building purposes.

In the tracts north-east and westward of Castlerea, good stones have been raised in different places, but no quarry more than of

local note has been worked. About three miles from the town there is a thin-bedded stone in the bed of the River Suck. It is in much request for walling, but is not good for out-stone purposes. The stone can only be procured in the summer, when the river is low.

On the tract to the north-east, between the town and French Park, there are many large field-stones, or "tumblers," which have been extensively used for local works, especially bridges, as they split easily. They have been of considerable profit to the occupiers, who sold them to those who required them. In the same area, near *Bellanagane*, are finely-laminated stones like the "Dunmore slates," which in the vicinity have been used for roofing purposes; they are also found in the north-east portion of Slieve-Dart that enters into this county at the extreme south-west. In Slieve-Dart are also found the stones formerly so much wrought into millstones, but perhaps more in the Galway portion than in this county. Eastward of *Bellanagane*, between it and *Mantua*, is a calcareous stone containing *silicious nodules* more or less similar to rough agates and cornelians.

Sandstone can also be obtained in the tract to the west of the Suck and south-west of Roscommon.

In the parish of *Fuerty* there is a quarry of excellent gritstone of peculiar solidity and hardness.

In Slieve-Baun there are some good brownish and yellowish stones; but they are now principally used for local purposes, the limestone being preferred for dressed work. To the south-east of Strokestown, in the south-west portion of Slieve-Baun, there are stones particularly adapted for millstones, and fifty years ago they were made in considerable quantities for supplying the adjoining counties to the eastward of the Shannon.

COAL-MEASURES.—These only occur at the north-west of the county. Some of the sandstones are reported to be of excellent quality, "equalling the Tyrone stone"; but they are so out of the way and inaccessible that very little is positively known about them. From the *Coal-measures*, however, are procurable excellent flags, somewhat like the Carlow flags, that formerly had a good sale; they were principally raised at Keadew and Arigna.

SAND AND GRAVEL.—In the low country there are Eskers which give an inexhaustible supply of excellent *pit sand* and *gravel*; some

of these, when of limestone-gravel, are excellent as manure, others of a different character are not. *River sand* also occurs very generally.

SLIGO.

In the little promontory (Rosses) between Drumcliff and Sligo Bays is a small outlier composed of metamorphic rocks; while coming in from Mayo, near the centre of the west mearing, and extending north-east across the county, is a portion of the Ox Mountain range. These hills, as has already been mentioned, have a nucleus of metamorphic rocks, which are probably the equivalents of the *Arenig*, or possibly of the *Cambrian* (page 213; *Mayo*, page 285), and margining them in places are *Lower Carboniferous Sandstones*. To the extreme south, in a small portion of the Curlew Mountains, there are *Silurians* of the "Old Red Sandstone" type, coming in from the neighbouring counties, Mayo and Roscommon, which are margined to the southward by *Lower Carboniferous Sandstones*. To the east of the county are *Coal-measures*, a small portion of the CONNAUGHT COAL-FIELD; while to the westward of the main mass are small outliers, lying east and west of Lough Arrow. In recent times sandstone has not been much used in this county for cut-stone purposes, as in general limestone is preferred.

CAMBRIANS (?), ARENIG, AND ORDOVICIAN.—The rocks that probably are the equivalents of those of these groups are all more or less metamorphosed. There are, however, in them some quartz-rock and quartzite, suited for heavy rough work and for road metal.

SILURIAN.—In the small area included in this county the rocks are similar to those adjoining, in the Co. Roscommon. They are of inferior quality for cut-stone purposes, being generally coarse and hard or argillaceous. They are, however, in places locally used.

CARBONIFEROUS. *Lower Carboniferous Sandstone*.—Some of the beds near Lough Gara, on the south slopes of the Curlew Mountains, are very similar to the rocks utilized at Boyle, in the Co. Roscommon; but here they do not seem to have been worked.

Westward of Ballysodare Bay and the neighbourhood of

Dromore West (parish of Kilmacshalgan) there are quarries of freestone.

To the west of the county, near Kilmacteige, and in other places farther eastward, margining the Ox Mountain range on the southward, there are in places fair-looking stones, but, as previously mentioned, not in request.

To the north-west of the Ox Mountains, in the neighbourhood of Dunowla, and to the south-west thereof, in the tract and strip of Lower Carboniferous and Calp (?) Sandstones, some of the stones appear as if they might be suited for dressing; but in no place are they sufficiently opened up to test their qualifications. South-east of Dromore, in *Doonbeakin* and *Ballyglass*, flags about 4 inches thick and up to 6 feet square have been quarried.

COAL-MEASURES.—Reports state that some of the beds of stone in this area are of good quality. They, however, are so inaccessible that they are not properly known. From these hills, however, are procured flags of the same class as the “Arigna flags,” which have been largely used throughout the county.

SAND AND GRAVEL.—*Pit sand* is not very plentiful, and varies in sharpness. It can, however, be got good about four miles from Sligo. In some of the rivers and streams there is good *river sand* and *gravel*. *Sea sand*, which can be collected in great quantities along the shore, is an excellent manure for potatoes, but should be spread for some months before the crop is put in, as otherwise its proper effects are not experienced. In places near the shore-line is a stratum of shell sand or gravel, for the most part made up of oyster-shells. This, in some places, is at least 60 feet above the present high-water mark. This deposit is not only itself a valuable manure, but it imparts its fertilizing qualities to the sand above and below it.

TIPPERARY.

The sandstones of this county, although now not much heard of, have a history; as both in ancient and the present times they have been very much used in preference to other kinds, even in places outside the margin of the sandstone areas. At Cashel, the older structures (Cormac's Chapel and the Round Tower), are of sandstone, except that in the Tower some of

the lower courses are of limestone, but in the adjoining churches, which were subsequently built, limestone was used. Some of the sandstone hereafter mentioned, if known, would be more sought after than it is at present.

The major portion of the area is occupied by limestone. We find, however, to the north-east, a little S. S. W. of Birr (Parsonstown), the small but conspicuous hill of Knocksheegowna, mostly *Ordovician*, but margined to the north-east and south by *Lower Carboniferous Sandstone*. Somewhat similarly, in the Arva Mountains, that lie to the east of the south arm of Lough Derg; in the group comprising the Silvermine Mountains and Slieve-Phelim; in Slieve-na-Muck, to the south of Tipperary; and in the portion of the Galtees that is included in this county there are *Ordovicians*, margined by *Lower Carboniferous Sandstones*. The Hill of Cullen, to the north-west of Tipperary, is *Lower Carboniferous Sandstone*; but the rocks of Knockmeeldown, to the south-east of the county, are probably in part *Devonians*, coming in from the neighbouring Counties Cork and Waterford.

To the south-east, in the neighbourhood of Killenaule and north-east of it, are *Coal-measures*, the EAST MUNSTER COAL-FIELD; while south-westward of the principal area are small, detached patches as outliers, which lie north of Cashel; north-east and south-west of Fethard; north-west of Clonmel; in Slieve-na-Muck, brought down by a great fault against the *Ordovicians*; and at Ballyporeen, in the valley between the Galtees and Knockmeeldown.

ORDOVICIAN.—These are, in general, in more or less inaccessible positions. When otherwise, nearly invariably the grits are in bad repute, as the associated slate rocks are preferred for local building purposes.

DEVONIANS.—The rocks of Knockmeeldown seem to be in part the representatives of the *Devonians* of the County of Cork, that is, the Passage-beds between the Silurians and the Carboniferous; while it is not impossible that the lower rocks of the Galtees to the northward, and of Slievenaman to the north-eastward, may be in part of this age, as the great thickness of the arenaceous rocks under the *Carboniferous Limestone*, as found in all these places, suggests that the Passage-rocks may be in part represented.

Knockmeeldown. In different places brownish, reddish, and yellowish. Free-working; durable. Has been extensively used in

Cloghreen, although the latter is in the limestone. A brown sandstone from these hills was used in the ancient castle at Cahir.

Mount Anglesey. A few miles from Cloghreen.—Brownish-yellow; silicious-grained; argillaceous cement; fine, but granular; friable; works freely and well; used for quoins, jambs, and other dressings; can be raised in long scantlings, and is capable of long bearings.

In the slopes of the Galtees, included in this area, good stones occur in numerous places: they vary from whitish to reddish and brownish in colour, some being more silicious than others. In general they work freely, and have been used in Cahir in preference to the limestone. These were used in the repairs of the old castle some forty or fifty years ago.

CARBONIFEROUS.—Lower Carboniferous Sandstone. These stones range from coarse reddish or brownish conglomerate to fine sandstone, in shades of light yellow, reddish, and brown or purplish. In Clonmel, where sandstone has been most used, it has been procured from the other side of the Suir, in the Co. Waterford. A similar remark is applicable to Carrick-on-Suir.

Tinnakilly. Six miles north-east of Carrick-on-Suir.—Yellow to brownish; silicious-grained; with little cement; ferriferous; very slightly micaceous. From here, and from Millvale, Co. Waterford, have been procured most of the sandstone used in Carrick.

Dundrum. About a mile from.—Yellowish-grey; very good texture; suitable for all kinds of dressed work. Mr. Sharp, the well-known Dublin builder, states that he believes this stone would be very generally used if it were known.

Drumbane. About seven miles southward of Thurles.—Whitish or light-grey; quartz-grains; argillaco-silicious cement; slightly ferriferous; works freely; can be raised in large scantlings. Was used in the Court-house, Nenagh, twenty miles distant, and in the Model School, Clonmel. This, like the Dundrum stone, ought to be more generally known; it is an admirable material, more durable than limestone, and very suitable for staircases, as it can be obtained in nearly any scantlings, and is capable of long bearings.

Carrick. Near Roscrea.—Light-brown; silicious; very little cement; fine-grained; dense.

In Roscrea, both in ancient and modern times, the local sandstone has been extensively used. A better quality has been brought from Ballinsally, Queen's County; but the old structures, as mentioned by Wilkinson, seem to be built of the local stone. In Cronan's Church and the Round Tower, the original working, as far as now preserved, seems to have been good; but the stones were not well selected, some now being very much disintegrated. The stones in the old castle are fine and thin-bedded, and although not so much weathered, they seem to have been weak, as some are cracked at their edges.

In other localities where the *Lower Carboniferous Sandstone* occurs margining the Ordovicians, good stone can in places be procured, and has been used locally. The conglomerates and coarse sandstones have been in request for bridges and walls, for which they are admirably suited, while in places they were formerly wrought into millstones. Thin-bedded stones, used as flagging in Cashel, are raised near Dundrum, and similar stones for flagging in Tipperary have been procured at Shrough, seven miles distant; they have also been used extensively in the military barracks there, and at Fermoy, Co. Cork.—(*James Newstead.*)

[As very superior stones are known to exist near Dundrum, and at Drumbane, southward of Thurles, similar veins ought also to occur elsewhere in the county margining the tracts of *Ordovicians*. But they have not been looked for, the stones of this county, as already mentioned, not being in the market, and, except locally, are not of note; but if inquired after they would probably be more in request than some now sought after.]

COAL-MEASURES.—In different places there are good stones for walling and rubble; but as they in general hammer badly, the quoins, sills, and other stones for dressed work are procured from the Devonian or Yellow Sandstone quarries.

In places in the Killenaule district, below the lowest coal, good flags can be raised.

SAND AND GRAVEL.—Near Roscrea, Thurles, and Tipperary, are Eskers, from which can be procured an unlimited supply of *pit sand* and *gravel*. Good sand can also be got near Clonmel and Nenagh, and an inferior kind near Cashel. *River sand* occurs in places in the Suir and the other rivers and streams.

The Esker sands, and also a marly gravel was formerly extensively used as manure. The latter was called *Corn gravel*, as it

gave excellent crops of wheat; but since the change in the climate which prevents the wheat from properly yielding and ripening, and the consequent falling off in that crop, it is not much used.

TYRONE.

This, at the present time, is the premier sandstone country: not, however, as regards quantity, but as to the quality to suit the present market; and also as to variety, they being of different colours, textures, and hardness, and belonging to various Geological groups and sub-groups.

To the northward, extending from near Omagh, north-eastward into Londonderry, is the tract of metamorphic rocks, suggested by Dr. Hinck as possibly of *Laurentian* age; but, as shown in the "Geol. Epit." (page 213), more probably the equivalents of the *Arenig*, or even possibly of the *Cambrian*. In the vicinity of Pome-roy, against these rocks is a small tract of rocks that possibly may in part represent the *Llandovery*, which, as given in the Table of Strata (Part 1., page 8), are the Passage-beds between the Silurian and the Ordovician; these rocks, however, are evidently nearer allied to the last than the first.

On the southward of these strata is a considerable and wide tract of *Silurian*, of the "Lower Old Red Sandstone" type—the eastern portion of the area already mentioned when describing Fermanagh (page 258); and still further to the southward, in places margining these rocks, is a narrow band of *Lower Carboniferous Sandstone*.

North of the TYRONE COAL-FIELD there is a tract of *Calp Sandstone* brought up by a fault, while there is a second south-west of Dungannon (Dungannon Park). Farther south-westward, north-east and south-east of Aughnacloy, are tracts of somewhat similar rocks that have been classed among the *Calp Sandstone*; but it should be pointed out that they are also more or less like the rocks of the *Fermanagh Series* (Lower Coal-Measures) of the Slieve-Beagh district, counties Fermanagh and Monaghan (page 259); while in the neighbourhood of Aughnacloy they appear to join into one another. It seems possible that in the latter neighbourhood the geology has not been properly worked out, and hereafter (north of the Tyrone Coal-field), it will be found that the Coal-

measures and Calp Sandstone are brought together by a fault, a downthrow to the south-eastward.

[All these lithologically similar rocks to the north-east of the Blackwater (Aughnacloy) are called on the new maps *Calp*, while west and south-west of that river they are called by the inappropriate English sub-group names, *Foredale beds* and *Millstone grits*.]

The well-known sandstones of the Co. Tyrone are all of Carboniferous age; but they may belong to the *Lower Carboniferous Sandstone*, the *Calp*, or the *Coal-measures*. The rocks in the neighbourhood of Aughnacloy, as already mentioned, may belong to either of the latter groups; here, provisionally, they will be described with those of the *Calp*. The *Calp* is of the two types, the ordinary, and the "Ulster type;" the rocks in these will be given separately.

[The subdivisions of "Upper and Lower Calciferous Series" adopted in the *Geological Survey Memoirs* are only lithological; the reddish pebbly rocks forming the latter. These dark-coloured rocks may, however, occur on any geological horizon, their colour and composition being solely due to islands, or other shore lines in the Carboniferous sea, they always being found adjoining a protrude of the older rocks.]

These rocks have been used in the county—very generally in Dungannon, Coalialand, Clogher, Omagh, Cookstown, Castlederg, and Caledon; while in Strabane, and other places in the schist regions, they are used for quoins and other dressed-stone purposes. At Baronscourt they were used, except the Portland stone for the staircases, and in a few other places. Out of the county they have been extensively used for cut-stone purposes.

Near Benburb, at the south margin of the county, are sandstones that have been said to be of *Permian* age; but on account of the assemblage of fossils in these and the associated rocks, and also of their position, Baily and the writer have suggested that they must belong to the *Carboniferous*.

In the northern portion of the county, at Cookstown and Kildress, at Omagh and south-east of Strabane, are tracts of *Calp*, of the "Ulster type" (*vide* page 224); while north of Dungannon, and further northward at Annaghone are *Coal-measures* (TYRONE COAL-FIELDS). Near Cookstown and Coagh, and extending southward past Dungannon into the Co. Armagh, *Trias* ("Red Free") is found.

The ORDOVICIAN grits are very little used even for local purposes, the associated slates being preferred for ordinary work. At Strabane, Castlederg, and other places in the north of the county the metamorphosed Ordovicians (*Micalyte*, *Argillyte*, &c.) are used for walling, the cut-stone work nearly invariably being Carboniferous Sandstone. Near Strabane flags are procured.

SILURIAN.—These range from conglomerate to fine sandstones; in general being silicious, but often argillaceous, or even carbonaceous. Similarly, as in the Co. Fermanagh, they have been used a little for cut-stone purposes, and are very suitable for coarse work, such as bridges and walls. Formerly, in some places, the very silicious varieties were wrought into millstones.

Lacagh. About two miles south-east of Fintona.—Purple and reddish; conglomeritic; yields sills and quoins; used in the building of Fintona new bridge.

Dungoran. Near Fintona.—Yellowish; grains white quartz; a little argillo-silicious cement.

Raveagh. Near Fintona.—Brown; makes good rubble; used in Raveagh House.

Dundiven. Three miles south-west of Fintona.—Cream colour, greyish-white, and greenish-grey. Rather argillaceous and felspathic; partly calcareous; granular; fine-grained; free-working.

Lackagh. Three miles from Fintona.—Dark-purplish; semi-crystalline.

Pomeroy. A mile from.—Dark-purplish grey; semi-crystalline; granular; micaceous; works fairly well.

LOWER CARBONIFEROUS SANDSTONE.—Generally greyish or yellowish in colour; some, however, reddish; more or less silicious; unequal grained; works freely, but soon wears the tools. In places some of the more silicious varieties were wrought into millstones.

Derrynascope. One mile from Augher.—Greyish and yellow; silicious-grained, with, in some beds, a reddish felspathic cement.

Dernasill. Four miles from Augher.—Greyish-white to yellowish; silicious; argillo-silicious cement; granular; micaceous; in some beds ferriferous.

Altaven. Five miles from Augher.—Greenish-white, with yellow seams; very quartzose; unequally grained.

Ballymagowan. One mile from Clogher.—Yellowish; white

silicious grains; a little felspathic cement; when ferriferous they have a reddish tinge.

Elderwood. Three miles from Fivemiletown.—Reddish; silicious grained; felspathic cement.

Cavey. One mile from Ballygawly.—Yellowish; silicious; a little cement; fine-grained; ferriferous. The conglomerates near Ballygawly were formerly wrought into millstones and flax-crushers.

CALP (Ulster type).—Many of them are beautiful stones—creamy or yellowish in colour, or with a bluish tint. In general they are free-working, open-grained, and capable of producing good work; some, however, are not suitable for heavy bearing. From the ancient buildings in which they were used they seem to be very durable.

These sandstones occur in limited thicknesses of strata, the “over-bearing” or cover-rocks being limestones or shale. This, as the quarry is worked in on the dip (which is low) of the stone, very often becomes excessive, so that the expense of removing it may become greater than the value of the stone. In other quarries the good stone occurs in more or less lenticular or other masses, adjoining which the stones are inferior. For these causes, quarries once famous are now worked out or abandoned.

Cookstown. In different quarries in the vicinity of.—Yellowish, creamy, or with a bluish tint; silicious-grained; a little argillo-silicious cement; open-grained; slightly micaceous; soft, and not suitable for heavy bearings. Mr. Dickinson states:—“Some of the beds are hard and excellent for all kinds of masonry.” From Tamlaght quarries were procured the stones used in the Lower Bann navigation works, while those used in the building of Killymore Castle came from the quarry nearly a mile north-west of the workhouse. Stones from the Cookstown quarries were also “used in the Provincial Bank, Belfast: a light, tough sandstone, hard to dress, and does not stand.”—(*W. Grey.*)

Kildress. Stones very similar to those of Cookstown.

Loughrea. South of Cookstown.—Similar stone.

Trinmadan. Nearly two miles from Gortin.—Yellowish; quartz grains; argillo-silicious cement; granular.

Carrickmore, four miles from Gortin; *Douglas Bridge,* eight miles from Strabane; *Mullinavarra,* three miles from Castlederg; *Derry-*

guinna and *Longfield*, where most of the stones used in the building of Baronscourt were procured; and *Drumquin*, west of Omagh. In these quarries the stones are more or less similar to those of Cookstown. From the Drumquin quarries were procured the stones for the pillars in the Omagh Courthouse.

At *Cookstown*, *Drumquin*, and *Carrickmore*, especially the latter, flagging has been procured for the neighbouring towns.

CALP.—These rocks occur to the north of the COALISLAND-COALFIELD, and in tracts of less or greater dimensions in the county, west and south-west of Dungannon. As pointed out previously, they are in some respects similar to the rocks of the *Slieve-Beagh* district.

Bloom Hill. About four miles north of Dungannon, and three from the Donaghmore Station, Great Northern Railway.—Two quarries, of different qualities and colour. Creamy, greyish-white, and reddish-yellow; the latter, or *Red-beds*, being inferior. Principally silicious-grained, very little cement, fine-grained. Some beds, especially the reds, are in part argillaceous and micaceous or ferriferous. Mr. Hardman states:—"The stone much resembles that at Gortnagluck and Carlan (presently mentioned), is equally good for building purposes, and has been much used."—(*G. S. M.*) It has been much used in Dublin and other places. In the Belfast banks, Donegal and Ballyshannon, it has been found very durable.

Gortnagluck and *Carlan.* About half a mile apart, and apparently on one set of strata, about two miles from the Donaghmore Station, Great Northern Railway.—Of slightly varied colour and quality; creamy, yellowish, greyish, white and reddish—the *Red-beds* being inferior. Silicious-grained; very little cement; slightly micaceous and ferriferous; cuts freely and well; can be raised of good scantlings; gets hard from exposure, and is durable when worked on its bed. It is a favourite for cut-stone purposes in Ballymena, Co. Antrim, where it is considered the best of the "Dungannon stone;" the Belfast people, however, seem to prefer the Ranfurly (Mullaghana) stone. It was used for all cut-stone purposes in Raveagh House, near Fintona; Convent of Mercy, Ballyshannon, Co. Donegal; Roman Catholic Church, Magherafelt, Co. Derry; Harbour Offices, Londonderry; and in various other places.

Spademill. An old quarry, now not of note.—Some of the beds excellent for scythe stones.

Ranfurlly or *Mullaghana*. Joined by a siding to the Dungannon Railway Station.—Creamy and yellowish; silicious; very little cement; fine-grained; lasting colour; difficult to work. The quarry, after being for some time closed, was recently worked, but is now (1887) again closed. Was used in the Post Office and Northern Bank, Belfast, and Northern Bank, Fintona; also in the addition to the Royal University, Dublin, where it has been found durable and to retain its colour.

The “Dungannon stone,” from some one or other of these different quarries, has been extensively used in Dungannon. According to a list, to which I am indebted to Mr. Dickinson, some of the principal buildings are: the Provincial Bank, Parish and Roman Catholic Churches, Shiel’s Institution, Police Barracks, and Parochial Hall. Elsewhere it has been used at Roxborough Castle, Moy; bridge over the Ballinderry river, near Coagh (cost £5000); the clock tower, and St. Patrick’s Church, Belfast. “These Dungannon stones, with those from Dungiven (Co. Londonderry), and Cookstown, were used promiscuously in the public offices (Post-office, Customs, and Inland Revenue), and the Apprentice Boys’ Memorial Hall, Londonderry; also with the Dungiven stone only in the Lunatic Asylum, where the stones from each quarry were used in a separate building. *Bloomhill*, for the gate-lodge and offices; *Gortnagluck*, for two separate wings; *Carlan*, in the doctor’s residence; and the *Dungiven*, in two octagonal wings and the front of the old portion of the asylum. In the military barracks, Omagh, Dungannon stone, of the inferior quality known as the *Red-beds*, was used; it works easily, but is not durable.”—(*J. Cockburn*.)

Aughnacloy.—Greyish to yellowish; silicious-grained. Also quarried three miles south-east of Aughnacloy.

Glencall. One mile from Aughnacloy.—Greyish-white; slightly stained with iron; very silicious; silicious cement; a little mica.

Brantry. Six miles south of Dungannon.—Purplish-grey; slightly variegated; semi-crystalline; granular; micaceous.

COAL-MEASURES.—Some of the arenaceous rocks of this subgroup, unlike those that in general occur in the measures of Munster and Leinster, are free-working stones. Rarely, however, can they be raised profitably, on account of the “clearing” or

“over-bearing” of drift, or useless rocks, that overlie them ; they are, however, inferior to the Calp Sandstone, and no quarry in them seems now to be worked.

Edendork. Two miles northward from Dungannon.—Reddish; fine-grained ; slightly micaceous ; soft ; not now worked.

SAND AND GRAVEL.—Eskers extend from Killymoon, near Cookstown, to Dungannon, and thence by Ballygawly, Clogher, and Fivemiletown into the county of Fermanagh ; in them there is an unlimited supply of good *pit sand* and *gravel*. Some of these so-called Eskers, as in the Pomeroy valley, are evidently *Glacial river gravel*. (See Monaghan, p. 292.) Good *pit sand* can also be procured near Gortin. *River sand* occurs in the Foyle, at Lifford Bridge, near Strabane ; in the Moyne, near Omagh, and elsewhere ; near Castlederg, and in many of the rivers and streams from the hills.

WATERFORD.

Occupying a considerable area in the east of the county is a large tract of *Ordovician*s. Overlying this, to the west, in the Monavullagh and Comeragh Mountains, are massive conglomerates, sandstones, and slates, which to me seem to be littoral accumulations of the West Cork and Kerry Devonians.¹ If this suggestion is correct, portion of the younger rocks, in the Galtees, to the northwest, and Slievenaman to the north, ought to be also Devonians. These Devonians, as in Cork and Kerry, seem to graduate upward without any quick or decided change, into the *Yellow Sandstone* or *Lower Carboniferous Sandstone* ; as in general the dips in both groups of rocks are similiar. This, however, is not always so, as in the neighbourhood of Glenpatrick, to the southward of Clonmel and Kilshelan, there is a sudden change in the direction of the dips, the later rocks dipping northward at low angles, and the older southward at high ones. This change may possibly only be due to a line of fault ; but it may be caused by an unconformability : it should, however, be more carefully examined into. However, to the southward in these hills, and also

¹ John Kelly, I think, was of a similar opinion, but I do not know exactly where he stated it.

farther west in Knockmeeldown, one group appears to graduate into the other; the Yellow Sandstone margining the Devonian. The Yellow Sandstones also occur in places eastward (estuary of the Suir), and in a band to the northward of the Ordovicians.

In the south division of the county, that is south of the valley from Dungarvan to the Blackwater at Lismore, there are, east and west, ridges of sandstones, separated by troughs of Carboniferous limestones or shales; and in these ridges, as in Cork, farther west, if there is a sufficient thickness of strata exposed, the Yellow Sandstone (*Lower Carboniferous Sandstone*) is found to graduate downward into the Devonian.

In the Bonmahon mining district, in two or three places, very small patches of red or purplish conglomerate and sandstone have been found lying on, or partly in, the Ordovician. These must be either of Silurian or Devonian age, probably the latter: that is, small outliers of the Comeragh conglomerates.

ORDOVICIAN.—The major portion of the grits and sandstones are not fitted for general cut-stone purposes, although some dress on the bedded surfaces; nor are they in much repute for common walling purposes, the associated slate being preferred, except in a few cases. There are, however, some green tuffose sandstones that are associated with the Exotic bedded rocks; these do not seem to have been much utilized in this county, although very similar rocks have been used during ancient and modern times, in the Co. Wexford, where they have produced good and durable work.

Grange Hill. Waterford.—Here there is a slaty grit that has been much used. It is very strong and hard, but very difficult to raise, on account of the absence of back joints; it dresses well on the face, but not on the edges. It was used in the ancient round castle, called Reginald's Tower, which shows the durability of the stone. The dressed work round the opening in this structure is of Carboniferous Sandstone, which has weathered much more, but evenly, than the Grange Hill stone.

DEVONIAN AND CARBONIFEROUS.—In the Co. Cork, the *Silurians* and *Devonians* are intimately connected, and hard to separate. They were, therefore, grouped together. In this county, however, it is not the beds below the *Devonians* but those above them that are intimately connected. It therefore is expedient here to group

the *Devonians* with the *Lower Carboniferous Sandstone* (Yellow Sandstone), and to describe the stones that occur in both together.

These stones are very generally used throughout the county, either for cut-stone or rubble purposes. The stones usually are shades of brown, green, and yellow. In the west of the county different varieties of stone are very much mixed up; as quite distinct stones very often occur together in one quarry. At *Skorough*, eastward of Lismore, in one quarry, there are four varieties, interstratified, ranging from finely-laminated slate to a gritty sandstone. A soft, earthy, felspathic, and micaceous stone, from Ballysaggart, was used in the dressings of the Roman Catholic Church, Lismore; while, about three miles eastward of the town, in one quarry there are roofing-slates, good flags, and free-stone, all of which were formerly worked. These slates, however, were eventually cut out by the Welsh slate. In the same town-land, but nearer Lismore, there is a stone fit for cut-work; but it varies in quality, the best being in beds from two and a-half to three feet thick. There are also other quarries, nearer to the town, but difficult of access. For the buildings in Lismore sandstone has principally been used; but in the church erected about fifty years ago limestone was used, and also in the mullions and windows of Lismore Castle.

Glenniveene. About five miles from Lismore.—Flags; difficult to dress, as they are liable to chip at the edges.

Slieve-Grian. In different places.—Light-coloured, silicious, felspathic cement; slightly micaceous; even-grained; porous; good quality; works freely. Very generally used for dressed work in Dungarvan, from which the quarries are distant some seven to nine miles.

In *Cappoquin*, the stone most used is a local thin-bedded, gritty, silicious, speckled sandstone.

Cappagh.—An excellent dry stone, but difficult to work, as it has no regular bedding or soles. Used in the new house at Cappagh. Green flags have also been procured in the neighbouring hills.

Ballyharahan and *Killongford*. Near Dungarvan.—Brownish and yellowish, but more usually variegated. Generally soft, fine, argillaceous, and micaceous on the bedded surfaces; porous, and easily worked. In the quarries there are some subordinate, felspathic, and more coarsely-grained beds, from twelve to fifteen

noes thick. Generally used, but often with limestone, for rubble and walling in Dungarvan, the dressing being Slieve-Grian stone or Whitechurch limestone.

Ardmore.—The ancient round tower, as pointed out by Wilkinson, "is a fine example of cut-stone masonry, and demonstrates the durability of the sandstone of the neighbourhood." "Walling in squared coursed work of reddish-grey sandstone, is in good preservation."

Clonmel Quarry. Half a mile from Clonmel.—Whitish to greenish; silicious; in some beds an argillaceous, silicious cement; works well. The sandstone generally used in Clonmel.

Millvale. Two miles from Carrick-on-Suir.—Reddish; silicious; with a little silicious cement; ferriferous. Has been largely used in Carrick.

Waterford.—The conglomerate that lies unconformably on the Ordovicians seems to be rarely used, except for road metal. About a mile from the town there is a quarry in reddish-brown, good sandstone; but as it is difficult of access, it is not now much used.

Brown Head Promontory. East of Tramore Bay.—Dark-red sandstone. It is very effective, with granite mouldings, in Newtown House, near Waterford.

To the east of the county, adjoining the estuary of the Suir and Barrow, there are limited tracts of conglomerate and sandstone well adapted for heavy work, such as piers and sea-walls, as they are capable of being raised in large squarish blocks. At Dunmore East there are good workable beds in the red sandstone cliffs, which have been locally used in sea-works; in the town and the coastguard-station: they are not durable. New Ross pier, Co. Wexford, is built of this class of stone; which was brought either from one of these tracts, or from that at Ballyhack and Arthurstown, Co. Wexford. Mr. Langrish states:—"The stone, from its hardness and roughness of surface, ought to make splendid coping for a quay wall, preferable to granite or limestone, which wear quite smooth."

SAND AND GRAVEL.—*Pit sand* and *gravel* are dispersed over the county, but generally not in quantity. In many cases the sand is very fine. At the round hill near Lismore there are good building and moulding sands, the latter used in the Cappoquin Foundry; also close to Ballyduff railway station. *River sand* is found in some of

the rivers and streams. For Waterford, they procure it about sixteen miles up the Suir, near Portlaw. "At Bonmahon there is a *sea sand* (*Æolian*) fit for almost any building or concrete. It is artificial, being due to the washings from the stamps when the copper mines were at work."—(*W. S. Duffén*).

GLASS.—Early in the century glass bottles were made opposite to Ballycarvel; and subsequently, about fifty years ago, there was a large glass manufactory. The "Gatchell or Waterford glass" was famous, this "Irish glass" having a name even in India, to which it was largely exported. It ceased about 1845, after the death of George Gatchell, as on his death the lease of the premises expired, and the landlord wanted to double the rent. This, combined with his widow wishing to retire to England—her native country—broke up the industry. A sand for cutting purposes is said to have been brought from the Co. Kilkenny, and the rest from the Isle of Wight, England.

[Flint sand is the principal ingredient in flint glass. There is also red-lead, pearl-ash, manganese, arsenic, &c., the ingredients and the quantity of each used depending on the METAL-MIXER. The metal-mixer locks himself into his room, and there mingles the several compounds. If his talent in this department leads to a good result, as was always the case in the Waterford glass when Walter Purcell was the metal-mixer, such a man can almost carry everything his own way.—(*George Miller*).]

WESTMEATH.

This area is occupied nearly solely by *Carboniferous* limestone. At Sion Hill, however, north of Killucan, there is a very small exposure of *Ordovician*, margined by *Lower Carboniferous Sandstone*, the latter rock also appearing in a few scattered exposures near Moate, and near Ballynacarrig, to the north-west of the county. These sandstones are of very limited extent, and are only used in their intermediate vicinities.

South-west of Mullingar, in the parish of Lynn, are some quarries of calcareo-argillaco-arenaceous flags.

SAND AND GRAVEL.—*Pit sand* and *gravel* are common throughout the county, and of a fair quality.

WEXFORD.

Under the major portion are *Cambrian*, *Ordovician*, and *Granite*; *Carboniferous* rocks only occurring in very limited tracts, as near Wexford Harbour, in a band across the baronies of Forth and Bargo, at Baginbun, in Hook Promontory, and on the edge of the estuary of the Suir, westward of Fethard, and at Ballyhack.

CAMBRIAN.—These rocks are in part metamorphosed. Some of the more hornblendic patches have been said to be of Laurentian age; as, however, such patches would be *Mosaics in the Cambrians* (to quote Dr. Callaway), it is far more probable that all are equivalents of the Cambrian (page 214). In these there are quartz-rock, quartzite, and grits, mostly unshapely, and more suited for road metal than any other purpose. Some of them, however, can be raised in large blocks, suitable for sea-walls, for which they have in places been used, as in the embankments of the north and south intakes.

ORDOVICIAN.—Usually the grits are only suitable for rough local walling; in places, however, there are more or less calcareous tuffose sandstones associated with the interbedded Exotic rocks. These, as exhibited in the ancient structures, such as the old buildings in Ferns and Wexford, if well selected, are durable stones; and are also capable of fine sculpturing, as seen in the beautiful Egyptian doorway of the little church of Clone, about a mile southward of Ferns. Of late years they have been used in Clone new church, and in some of the bridges of the Dublin and Wexford Railway. It is a stone that ought to be more generally used, being very free-working, easily raised, and durable if well selected. When first worked, the colour is greenish-grey; it then becomes discoloured, but this discolouring seems subsequently to wash out if we may judge of the stones as they now appear in the old buildings. If, as in the States of America, sawing was introduced into our quarries, this would be an admirable stone to be thus worked, as it is light and porous, and might be cut into sizes from the scantling of brick to those of quoins, sills, &c. It seems capable of heavy and long bearings.

Ballymore, near Gorey.—A sandstone quarry; but it is jointy,

and does not work well; Bagnalstown granite was preferred to it for the dressing of Kilternel Church, Courtown.

CARBONIFEROUS.—*Lower Carboniferous Sandstones* are yellowish and reddish shaly sandstones, and more or less coarse conglomerates. In the neighbourhood of Wexford Harbour they have been quarried, principally near Castlebridge, at Artramon, at Saunder's Court, and at Park. From the latter were procured the stones for the "Father Roche's Churches" in Wexford. It is a pebbly sandstone or fine conglomerate, and gives a picturesque and unique aspect to the buildings. As pointed out by Wilkinson, it is a peculiar stone, and must be understood by the masons, as under ordinary circumstances it would be rejected, and an inferior stone preferred. If, however, it is dressed immediately on being raised it works well, and makes sound, durable, and dry work. It was in part used in the old abbey at Wexford. As it can be raised in squarish blocks, it is also very suitable for quay walls, and such like large work.

A more or less similar stone, and a yellowish sandstone has been quarried in places in the baronies of Forth and Burgoyne, especially near Duncormick.

At *Baginbun*, in the *Hook Promontory*, south of Duncannon, and at *Ballyhack*, there are massive conglomerates and sandstones that can be raised in large blocks suitable for piers and such like, having been used, among other places, in the pier at Kilmore. Near Arthurstown are quarries of good grits, formerly much used for millstones. (See *Waterford*.)

[In most of the old ecclesiastical buildings in this county, a stone very similar to the caenstone has been largely used. Some caen may have been used; but, as pointed out by Mr. Robertson of Kilkenny, the stone is probably Douling stone, from near Glastonbury, England. (See *Kilkenny*.)]

SAND AND GRAVEL.—In this county, below the 250-foot contour level in places, there are vast accumulations of *manure gravel*, a shelly sand, formerly much used for bedding cattle, and afterwards as manure. This, to the northward near Gorey, and between Enniscorthy and Newtownbarry, graduates into ordinary sands and gravels, those in the Slaney valley being for the greater part limestone. There are also, for miles along the coastline, large tracts of *Æolian sand*; this, also, in places was formerly

used as manure on the "marl land," being considered most beneficial if brought from below high-water mark "with the sea in it:" that is, when wet and salty, it was considered better than if the salt was worked out of it.

In the Gorey district, and the upper portion of the Slaney valley, there is good *pit sand* and *gravel*, also at the Deeps, to the northward of Wexford, and in some other places. Good *river sand* can be procured in limited portions of the Slaney, and the other rivers and streams.

WICKLOW.

In this county sandstones or allied rocks that are now in favour for cut-stone purposes are few. The area is solely occupied by *Granite*, *Cambrian*, and *Ordovician*, the latter in a great measure metamorphosed.

In the CAMBRIAN at Bray Head, and also in the hills north-east of Togher or Roundwood, there are extremely hard green grits, and, in other places, the quartz rocks are well suited for road-metal; but some of the more regularly-bedded and granular varieties of the quartzites might possibly be worked.

Glencormick. North of the Great Sugarloaf.—Warm cream colour; fine-grained; silicious, thin-bedded; cuts easily and well. Extensively used in Bray and other places in that neighbourhood.—(*T. B. Grierson*.)

In the less altered ORDOVICIANS, near the west margin of the county, are interbedded green tuffose sandstones, allied to those described in the Co. Wexford. Some of them were used in the old structures, and gave good, durable work. At the Seven Churches, Glendalough, in the building now called "St. Kevin's Kitchen," a metamorphosed stone, apparently of this class, was cut to the slope of the stone roof, besides being worked in other ways, as in a carving over the doorway of the structure now called "The Library."

SAND AND GRAVEL.—*Pit sand* and *gravel* occurs in places in nearly all the valleys; and from the washing of them by the streams, good *river sands* are produced.

For long distances along the seaboard are greater or less accumulations of *Æolian Sand*. At Arklow, the fine sand drifted

through the rampart at the Chemical Works is sent to Dublin to be used in the sawing of blocks of stone and for polishing. This, as mentioned in the "Introduction" (page 227), suggests a new industry.

GLASS.—At Melitia, westward of Shillelagh, and about two miles from the ancient church of Aughowle, there is the site of an ancient glass-house, to which attention has recently been directed by the Rev. J. F. M. Ffrench (*Jour. Roy. Hist. Arch. Ass., Ire.*, vol. vii., 4th ser., p. 420). In the neighbourhood there is a sand which the glass-workers of Dublin state, "if ground down, it ought to be a suitable sand." Glass seems also to have been manufactured at the Chamney Iron Furnace, Shillelagh, as some years ago, when removing part of the old ruins, a quantity of glass slag was found.

In the townland of Ballymanus, westward of Aughrim railway station, there is a dyke of fine white sand, evidently a decomposed felsitic rock. This has been submitted to the glassmakers at Ringsend, Co. Dublin, who state it is too clayey for clear glass, but ought to be excellent for black glass. To meet the Dublin market it would have to be delivered at about 3s. per ton.

NOTES ADDED IN THE PRESS.

CO. DONEGAL.

Dunmore Head; and *Croagh*—Innishowen—one and a-half miles south-west of Dunmore Quay, and two and a-half miles south-west of Culduff. Bluish-grey quartzose flags can be raised in squares from 6 to 10 feet, and of all thicknesses, some thin enough to be used as roofing-slates.—(*A. M'Henry*).

Kindrum — Fanad-within-the-Waters — west of Kindrum Lough.—Veins of thin, micaceous silicious flags can be raised in large sizes, capable of long bearings; mottled whitish-yellow, or pinkish colour. This stone appears capable of being sawn, and ought to be effective if used in fancy tiling.

Shanaghan—Ardara—near Shanaghan Lough, and other places in Loughros Promontory.—Vein of micaceous-silicious flags, from two inches or more to the thickness of roofing-slates, for which purpose they have been used; can be raised of considerable sizes, capable of long bearings.

Slieveleague—Carriak. Silicious flags.

CO. DUBLIN.

Ringsend glass.—For black, Irishtown sand; for clear, Antwerp sand; about 9s. per ton; or "Granuloid" (Portsmouth). The latter is a finely-granular quartz rock; it is supplied in blocks, costing about £1 per ton.

The following are the ingredients used in the manufacture of black and clear glass, respectively:—

Black Glass.

Irishtown sand.
Waste lime (after manufacture of mineral waters).
Blue clay.
Broken tiles.
Kelp waste (substitute for soda ash).
Rocksalt.
Fluorspar.

Clear Glass.

Antwerp sand.
Whiting (Glenarm).
Soda ash.
Red lead.
Manganese.

To make twenty gross of mineral water, or fifteen gross of brandy bottles, which is the quantity usually run from a furnace:—

- 18 cwt. Antwerp sand.
- 4½ „ chalk (or whiting).
- 2 „ soda ash.
- 2 „ sulphate of soda.
- 4 lbs. red lead.
- 2 „ arsenic.
- 2 „ manganese.

About 1 ton of waste glass, such as broken window-glass.

The “Granuloid,” when used, is thrown in, in the block, which rapidly melts down.

A rock very similar in aspect to the “Granuloid” occurs in the Howth Promontory, also in places in the counties Wicklow, Wexford, and elsewhere in Ireland.—(*R. Clarke.*)

ECONOMIC GEOLOGY OF IRELAND.

IV.—IRISH ARENACEOUS ROCKS—SUPPLEMENT.

[In this Supplement information is given which was either omitted in my previous Paper¹ on this subject, or has been obtained since that Paper was written. A classification of paving setts has not as yet appeared, which omission is now rectified, while the subject of mosaic pavement is also referred to. I also give some information as to the durability and selection of stones, taken from the valuable Papers of Dr. Julien of New York.]

[Read November 16, 1887.]

THE durability of building-stones and their selection is most important; therefore it may be allowable to refer to Papers by Dr. Alexis A. Julien "On the Decay of the Building Stones of New York City," abstracts of which appeared in the *Trans. New York Acad. Sci.*, 1883, pp. 67, &c., as in them there is interesting and valuable information applicable more or less to the Irish stones. The stones used in New York are principally sandstone, marble, granite, and gneiss—over 80 per cent. being sandstones. In consequence of the frequent fires in that city, stone buildings are preferred to frame-houses; but, on account of the friable nature of the stone generally used, brick and stucco have been much in request—frame-houses being 42·5, brick and stucco 47·9, stone 9·1, and iron 0·5 per cent. of the whole.

Although in New York there are some excellent stone structures, the severe competition has caused great quantities of most inferior sandstone to be employed in building. Some of the coarse sandstones in use last only from 5 to 15 years, but the best fine stones have lasted from 100 to 200; the coarse limestones last from 20 to 40 years, but some of the fine marbles have lasted 200; the granites have lasted from 75 to 200 years; while the gneiss appears to be more durable. In the great majority of the buildings, however, sandstones of bad quality have been used.

¹ Vol. viii., pp. 205–318.

The durability of a stone depends partly upon the chemical composition of its constituents and of their cement. "This involves a consideration of their solubility in atmospheric waters; *e.g.* the calcium (carbonates of a marble or limestone), the ferric oxide of certain sandstones, &c.; their tendency to oxidation, hydration, and decomposition, *e.g.* of the sulphides (especially marcasite), in roofing-slates, limestones, &c.; the biotite and ferruginous orthoclase in a granite or sandstone, &c.; the enclosure of fluid and moisture, *e.g.* as 'quarry sap' in chemical combination—as hydrated silicates (chlorite, kaolin, &c.) and iron oxides, and as fluid-cavities locked up in quartz," &c. The durability of a stone depends also upon its physical structure in regard to the following, viz.: the size, form, and disposition of its constituents. For instance, an excess of mica plates in parallel position may be an element of weakness; the porosity of the rock permitting the percolation of water through its interstices; the hardness and toughness; the crystalline structure; the tension of the grains (which appears especially to explain the disruption of many crystalline marbles); the contiguity of the grains, and the proportion of cement in their interstices, and the homogeneity of the rock. "Again, the durability of a rock may depend on the character of its surface, whether polished, smoothly dressed, or rough hewn; since upon these circumstances may depend the rapidity with which atmospheric waters are shed, or with which the disposition of soot, street-dust, &c., may be promoted; also on the inclination and position of the surface, as affecting the retention of rain-water and moisture, exposure to northerly gales and to burning suns," &c.

The agencies concerned in the process of destruction belong to three classes, viz. chemical, physical, and organic. The chemical agents are sulphurous and sulphuric acids, discharged in vast quantities into the air of a city from the combustion of coal and gas, sewer gas, the decomposition of street refuse, &c.; carbonic, nitric, and hydrochloric acids; carbolic, hippuric, and many other acids, derived from smoke, street-dust, sewer exhalations, &c.; oxygen, ozone, ammonia, and sea-salt.

The more prominent *mechanical* and *physical* agencies are: extreme variations in temperature, wind and rain (to which some faces of a building are more exposed than others), crystallization by efflorescence, pressure of superincumbent masonry, friction, and fire.

The natural method of ascertaining the durability of stone, suggested by the author, is the examination of the outcrop of the beds, "where the exposure of the surface of the rock during ages may give some indication of its power of resistance to decomposition; and the examination of stones in old structures." He specially points out the examination of stones in monoliths and tombstones: "There could hardly be devised a better method for thoroughly testing, by natural means, the durability of the stone than by its erection in this way, with partial insertion in the moist earth, complete exposure to the wind, rain, and sun, on every side, its bedding-lamination standing on edge, and several of its surfaces smoothed and polished, and sharply incised with dates, inscriptions, and carvings, by which to detect and to measure the character and extent of the decay."

As to the *seasoning* of stones, it is recorded that Vitruvius recommended it 2000 years ago, and that it has "been observed at times down to the days of Sir Christopher Wren, who would not accept the stone which he proposed to use in St. Paul's cathedral, in London, until it had lain for three years seasoning on the seashore. Since then little or no attention appears to have been paid to this important requirement by modern architects, in the heedless haste of the energy of the times. Building-stone, even for many notable edifices, is hurried from the quarries into its position in masonry long before the 'quarry sap' has been permitted, by its evaporation, to produce solid cementation in the interstices of the stone."

The pernicious effect of placing stones on their edges, and not on their bed-surfaces, is also mentioned, and the carelessness with which stones are selected and used.

While pointing out the effect of the different denudants on stone, it is mentioned by Dr. Julien that no material differences were remarked by him in graveyards near *the sea* and in those away from it. It seems, however, to be otherwise in Ireland, as the sandstones, slates, limestones, granite, &c., on the coasts of Cork, Kerry, Clare, and Galway, are recorded as having weathered more and differently from those inland (G. S. M.). *Heat* has a considerable effect, as stones exposed to the sun are more weathered than those which are constantly in the shade. *Lichens* do not seem to have much effect, as, "on their removal, the surface of

the stone beneath is not found corroded ; it only retains a fresh colour." *Imperfect pointing* is most deleterious, as it exposes the stones, as it were, in flank, to freezing, solution by rain, hydration, &c.

[In Ireland, although there are no very sudden changes between great heat and cold, yet the frequent alternations during winter of freezing and thawing cause a considerable amount of denudation, as can be seen in walls and natural rock-faces exposed to the mid-day sun : the sudden changes from wet to dry in summer have also a marked effect. Wind, not only in this but also in other climates, has more power as a denudant than it is generally given credit for. Strong winds in dry weather, carrying gritty particles, will act similarly to "sand-blasts," especially in eddies round corners, under-cutting the joints in buildings, and eroding grooves along the bedding and other lines in natural surfaces. Wind after rain dries the saturated surfaces and enters the minute shrinkage fissures, thus cutting out the particles, to carry them away and use them as "sand blasts" elsewhere. If wind and rain are combined, the latter is driven into the faces of walls, so that they have to be protected by weather-slatting, cement, or some such appliances. The effects of wind, combined either with carried particles of sand or rain, may be observed in all exposed places—on buildings, monoliths, tombs, surface-blocks, and cliffs, especially at the earth-line, where they are more or less under-cut. In our climate some stones, such as granite and allied rocks, sandstone and slate, seem nearly always to be protected from weathering by those lichens that grow in sheets ; but those that grow in branching tufts from a small root seem to promote decay. But all lichens seem to induce weathering in limestone, and even in slightly calcareous rocks : the decay being apparently due to the acids generated by those plants.

In former publications I have shown that in all classes of rocks there are some that are chemically hard, although physically soft ; while there are others which are physically hard, although they may be chemically soft. These characteristics must be taken into consideration in selecting stones for different purposes. Chemically hard stones may be most suitable for building purposes, while unsuitable for places where they are subject to wear and tear ; while the opposite may be the case with physically hard materials.

In sea works, that are exposed when the tide is out, as also in those above high water which are wetted during storms, or such like, some stones weather peculiarly ; irregular holes wearing out ; or, if they are cleaved rocks, the cleavage planes becoming developed. Cement, which is an artificially-formed calcareous rock, is in some places curiously licked out by sea or brackish water. This I have specially remarked at New Ross, on the Barrow, Co. Wexford, where the walls were pinned with wooden pegs, these being more durable than cement ; and also in a wall at the north end of the Esplanade, Bray, Co. Wicklow. This action of sea-water seems to be in part the mechanical result of the sudden wetting and drying of the rocks ; and in part the chemical result of the action of acids, and the formation of salts that are easily dissolved.]

PAVING-SETTS.—Paving must have been in vogue at a very early date, as it is found in prehistoric structures, such as the large crannog in Lough Rea, Co. Galway, where the stones were well

selected. In early times the stones principally used were the naturally-rounded ones procured from the drift, or the beaches of rivers, lakes, and the sea, or some other natural accumulations. Sometimes they were well selected, both as to hardness and size; but often this was not so, as is at present the case in parts of the city of Glasgow and elsewhere; and consequently the surface after a time became rough and uneven. This appears to be one of the great reasons why, at the beginning of this century, Macadam's plan of making roads with broken stone was received with such great favour.

The early artificial paving-stones, or setts, seem to have been principally made of soft materials, that split readily; and in this country they were generally of limestone, or other soft materials, that are now universally condemned. The setts in the market seem to be generally classed by the trade as *black setts* and *white setts*. The first formerly included both the limestone and the whinstone, although the term is now more generally appropriated to the latter; while "white setts" include the granite and the grits. Limestones are classed by themselves.

The stone for paving-setts should split easily, thus requiring little or no after-dressing. It should be durable, that is, capable of resisting crushing and surface wear; and when subjected to traffic its surface should not become soapy or glassy. It is, however, very difficult to find a stone having all these qualities combined. Many of the *limestones* split easily, and are cheaply wrought; but in general they are friable or soft; while those that are tough or silicious, especially the first, receive a more or less soapy polish. Limestone-setts are suitable only for places where there is very little traffic; but on account of their cheapness they can very profitably be used for pathways. The *whinstones* almost always are hard, durable, and capable of resisting crushing and wear; but they have to be selected with great care, as many, especially some of those that are tough and hard, readily acquire a soapy-polished surface, which makes them unsuitable for a good pavement. *Granites* perhaps make the most comfortable road; but they are generally less durable than whinstones; while the hardest or quartzose varieties are liable to take a glassy polish. *Grits* are very variable in character, from open to compact and quartzose. Some of the hard quartzose grits split, or rather break

up naturally into sizes suitable for setts, and consequently can be very cheaply wrought; but unfortunately they are often liable to receive a glassy polish. A quartzose felspathic grit, however, if it splits easily, is a cheap and good stone.

Some localities where good grit setts can be procured have been mentioned in my previous Paper.¹ The Irish localities from which granite and whinstone setts are now sent into the market will be mentioned hereafter in the section treating on those rocks.

Mosaic Pavement has lately been more or less in demand. The ancient Romans used principally fragments of marble, introducing, however, pieces of glass and terra cotta to give tints. The modern Italians also use principally marble fragments. Messrs. Sibthorpe and Son, of Dublin, are trying to start a new Irish industry by bringing over Italians to teach Irish workmen the art. Mosaic pavement, consisting entirely of terra cotta, seems to be a modern invention.

A sort of rough mosaic work is seen in some of the English towns, pieces of flags placed on edge being used for pavement. For similar work there is plenty of materials in Ireland at the various flag quarries, especially those of Kilkenny and Clare, where the detritus might readily and cheaply be dressed into setts suitable for pathways and such like. These, if cut, would make a beautiful floor, permanent in character, and unique in appearance.

ANTRIM.

Portrush.—Church of the Holy Trinity, Portrush, Mr. Christie's quarry, Dunmurry, Draperstown, Co. Londonderry. The stone, when raised from the quarry, deep red, but when dressed, pale pink, and some beds whiteish. Dresses very fine, and especially suitable for fine inside work. The blocks should be laid on their quarry beds. All the columns and part of the windows are of this stone. New Wesleyan Church; from Altmore, Dungiven, Co. Londonderry, and Gortnaglosh, Dungannon, Co. Tyrone. The Altmore stone—yellowish, coarse-grained, and rather hard; used for quoins and courses without mouldings. The Gortnaglosh stone is of a buff colour, fine-grained, and especially suitable for mouldings and dressed windows; the large windows and porch of this stone. In places it shows slight iron stains. (*R. G. Symes.*)

¹ Vol. viii., pp. 241, 261, &c.

CORK.

Glanmire Quarry.—Good, rich, red, capital building-stone, even when set on edge. In many fine buildings this stone has been used, such as the following in the city of Cork:—SS. Peter and Paul's Church and Convent; Roman Catholic Cathedral; St. Vincent's Church and Convent, Sunday's Well; Dominican Convent, Pope's-quay; St. Mary-of-the-Isle Convent New Orphanage; the Incurable Hospital, and others. All these buildings have limestone dressings. Most of the brown stone flags used in Cork have been procured here, while the bottom bed, a greenish-grey hard stone, is used for macadamizing. Smaller quarries to the northward of the city with the same class of stone. St. Luke's Church, lately burnt down, was built of a duller stone from the quarry north of the Police Barracks. The Police Court, and many other buildings, are built of sandstone, with limestone dressings. (*R. W. Johnson.*)

Rostellan, near Midleton. Good sand, formerly used in the glass-houses, Cork.

DONEGAL.

Dromkeelan, near Mount Charles.—This stone, lately brought prominently forward, has a good character if set on its natural bed; but if set on edge it is friable and peels off.

Glenalla, a little north of the church-green.—The stone rises in large blocks; punches well. Used in the foundation and lower courses of the church and Glebe House. (*F. M'Fadden.*)

Creeve, north-west of Rathmullen.—Good scythe-stones.

At different places in the tracts of quartzite and sandstone that extend from Lough Swilly, near Rathmullen, to and beyond Ramelton, there are beds of a sound stone which rises in large, squarish blocks; very suitable for rough walling, as also for sea-walls, foundations, and coping of bridges.

Margining Ballymastocker Bay, Lough Swilly, there are dunes of æolian drift: these are principally composed of highly *calcareous sand*, very valuable as a manure. It ought to be much more utilised than it is at present, as it could be easily carried by boat to great distances.

Associated with the sand dunes, and at times within them, are peculiar thin-bedded horizontal friable calcareous *sandstones*, suitable for farm walls. The mode of formation of these horizontal sandstones is hard to conjecture, as they seem to have been originally æolian drift, which is not horizontally bedded. They seem to have been cemented from the outside inwards, as in places the middle parts of the beds are uncemented: on these the wind acts, and consequently the sandstone is very much tumbled about.

TYRONE.

Douglas Bridge, eight miles south of Strabane.—The stone here has been extensively used for cut-stone purposes in Strabane, and in Letterkenny, Co. Donegal (twenty-seven miles distant); easily worked; stones all dressed in the quarry.

WEXFORD.

With reference to the epitome of the geology of this county, we may take this opportunity of adding the following, which is of special interest.

Baginbun, N.N.W. of Baginbun Point, on the coast S.E. of Fethard, are conglomerates which dip N.N.W., and appear to lie unconformably on greyish and blackish slates and grits, which dip S.S.E. at high angles. In one bed graptolites were found; but further south are conglomeritic slaty rocks, unlike any of the Ordovicians of the county, but very similar to some of the Cambrians, especially those at Ferrycarrig, N.W. of Wexford town (G. S. M.). Some of the early explorers considered the Fethard conglomerate to be the base of the Ordovician; but the graptolites in the beds below it were considered fatal to such a conclusion. What has now been ascertained in the Co. Donegal may suggest a solution, as these dark beds with graptolites, between the Fethard conglomerate and the Baginbun beds, may belong to a portion of the ARENIGS. If the existence of Arenigs can be proved here, it would, perhaps, also suggest that farther north a band of similar rocks may have extended obliquely north-eastward from Killurin and Ferrycarrig to the sea, having to the northward and southward the typical *Oldhamia*-bearing Cambrians. The beds in the neighbourhood of Ferrycarrig are very similar to those at Baginbun.

V.—SLATES AND CLAYS (BRICKS, ETC.). BY G. H. KINAHAN, M. R. I. A. WITH INTRODUCTION AND BUILDING NOTES BY R. CLARK.

[Read January 18, 1888.]

[The order followed is, first, to give a general description of the slates and clays, and then to treat of the *slates*, both for roofing and general purposes, according to the counties arranged in alphabetical order, and to conclude with the *clays*, similarly arranged. As to the latter, the uses to which they can be put will be mentioned, especially brick-making. The prices of bricks vary very much, and very rapidly. From inquiries made, and the Records, it would appear that the prices before 1850 and at the present time are very similar. Between 1850 and 1860 they fell to a minimum, in fact they then scarcely exceeded expenses; after 1860 they gradually rose to a maximum, between 1870 and 1880; while now they are very low. The average sizes and weights of bricks in country places are those given by Wilkinson, as they do not seem to have changed; but in the vicinity of Dublin, Belfast, and a few other places new sizes and weight have been introduced.]

INTRODUCTION.

THIS Paper, which is in continuation of the series of Papers on Irish Economic Geology, commencing with "Irish Metal Mining,"¹ proposes to review former efforts at working the slates and clays of Ireland, and also to point out such localities as the writers believe to offer favourable prospects for the opening of new works, or the extension of those already in existence; and for developing the abundant resources available to us for the manufacture of Slates, and for the numerous branches of the brick and potter trades.

The working of Irish slate formations, and the manufacture of pottery, earthenware, and bricks have been carried on from very remote periods, and more or less successfully at times, though none of those industries ever attained such a reputation as might have been expected from the abundance and excellence of the material, and the readiness with which cheap labour, suitable for carrying on the necessary works, is procurable in Ireland.

¹ *Vide* Vol. viii., p. 3.

Careful inquiries on the subject of the decay of the Irish slate and brick trades make it apparent that the Irish manufacturers are themselves in no small degree accountable for the low state to which they have been, for years past, reduced. The improvements and changes necessitated by the requirements of modern architecture were, in great part, neglected, and some of the goods, though excellent in quality, so far as durability was concerned, were unable to compete with the more highly finished articles placed on our markets by our neighbours, who have accordingly, for the past thirty or forty years, maintained a monopoly of the supply of the better descriptions of building materials required in this country. This is by no means a satisfactory state of affairs in a country which, from advantages before referred to, should not alone be able to supply its own wants, but have been an extensive exporter of the goods it has so long imported.

Like most other industries, the production of building materials in many districts succumbed to the shock of the disastrous period preceding the year 1850. The abundant labour available in the country at that time fled to other fields, and the enterprises being almost exclusively in the hands of small capitalists who were unable to stem the tide of adversity which had set against them. The recurrence of better times, and the consequent revival of trade in general, found the Irish brick and slate trade in many cases either annihilated, or in such a depressed condition as to afford an opportunity for importation from elsewhere, which eventually, with but few exceptions, drove the native production out of its natural market. As the foreign article was, in general, very superior in appearance and finish to the Irish then procurable, the latter was soon relegated to work of secondary character, and from that position it did not recover until within the past few years, when some works have been started which bid fair to successfully compete with their rivals across the Channel.

THE IRISH SLATE TRADE has never been attempted to be developed with the energy or perseverance which the material at command undoubtedly deserves. With a few exceptions in the vast number of so-called slate quarries, the workings merely consist of surface-grubbing, where nothing but the more or less weathered upper part of the slate-rock is met with, and in many instances the dressing of the slate is done in such a crude style as

to be almost ludicrous. Again, even in quarries where a better state of things exists, and the slates are extracted from a moderate depth, where also some regard is paid to their trimming, the workings will often be found choked with the *debris* which has been allowed to accumulate from no provision having been made for its removal. Of course there are quarries where the arrangements are nearly perfect; but in general the Irish slate quarries have been worked in a more or less primitive fashion.

The rocks of Ireland offer a promising field for a great extension of the existing slate trade, as will appear hereafter. There is no apparent reason why the project should not be carried to a successful issue, if it were energetically and properly taken in hand and followed out, it being but a question of time and money to produce as good an article as the Welsh slate, which has, in a great measure, excluded the home article for many years past.

It should, however, be borne in mind that the principal obstacle to the development of the Irish slate trade has been the small capitals with which most of the enterprises were started, the capital in many cases not being more than sufficient to clear the off-baring from the quarries; so that long before the proper depth was reached the capital was exhausted, while inferior slates from the weathered portions of the rock were put on the market in the anxiety to earn a dividend, thereby giving the slate a bad reputation, and ruining the undertaking. The oft-repeated failures of the Irish slate quarries are therefore in general to be attributed to the lack of the two essentials—time and money—but, as already mentioned, there is every reason to hope that a fair expenditure of these necessities would result in the production of a good article, always in demand, and thereby bring back to this country the advantage of a flourishing remunerative trade.

IRISH CLAYS have been, from pre-historic times, applied to various uses by the inhabitants of the country, though almost entirely to the making of articles of pottery, until more recent periods. In the kitchen-middens, so abundant in the sandhills on the coast of Co. Antrim, are found numerous specimens of rudely-baked and ornamented pottery, associated with flint and bone implements, and probably formed from the Lias clay of the vicinity. These, from various indications, would appear to have been used for cooking purposes. The funeral urns, which have been so often

exhumed from the ancient places of sepulture, are often of very finished workmanship as compared with the utensils just referred to, some of them being ornamented with designs of no small artistic merits.

The manufacture of bricks in Ireland does not date back to anything like the antiquity of that of pottery—a fact borne out by the entire absence of any trace of such in the ancient structures so numerous throughout the greater part of this country.

As late as the year 1641 Gerrard Boate wrote as follows :—“ In every part of Ireland there is found a kind of clay fit for to make bricks and all sorts of potters’ ware, although the Irish never had the wit or industry to make use of it for either of these ends ; yea, they have ever been so far from making any earthen vessels, that even the use thereof hath been very rare amongst them, and to the most part unknown, not only before the coming in of the English, but also since, yea, even until these very last times, although a great number of English potters, in several parts of the land, had set up their trade, so as all kind of earthenware was very common, and was to be had at very easy rates.

“ And as for the bricks, they have been little used in Ireland, even among the English themselves, for a great while ; but of late years they began to be very common, as well in the country as in the cities, especially Dublin, where all the new buildings (the which not only in handsomeness, but also in number, do surpass the old) are all made of brick. But that which is made in Ireland, for the most part, is not so good as that of other countries, not so much for any unfitness in the clay itself, as for want of handling and preparing it aright—as may easily be conceived by the following description of the manner they use to make it.”

Boate then gives a lengthened account of the manufacture of bricks, as then carried on ; but, as the information he gives of the manufacture of potters’ ware is rather inaccurate, it is perhaps unnecessary to recapitulate his version of brickmaking further than to state that he estimates the value of the brick at six to eight shillings per thousand. As regards the manufacture of pottery, it is strange that a writer of Boate’s abilities as an investigator should have been unaware that pottery had been extensively made by the ancient Irish ; whilst as to brick, the early English structures in this country rarely contain more traces of brick work

than do those of the Irish. Boate also mentions that "tiles are imported from Holland for covering houses," and comments on the great abundance of slates which could be raised with little "charge and labour." It is, however, worthy of note that about this period tiled houses were the prevalent fashion in England, and it is quite possible that the custom was introduced by the English settlers.

It would be impossible, in a Paper of this description, to enumerate all the various places throughout Ireland in which bricks have been burnt formerly, because as now a kiln might be burnt, solely for local use, and little or no record of it left. Nor are the prices which are mentioned in general an indication of the quality of the article. Local causes, such as the paucity of fuel in the neighbourhood in which the bricks are burnt, or the distance same have to be carted to a railway or shipping port, are often an important factor in determining the price, as really inferior bricks in one place, on account of local circumstances, will fetch a much larger price than that obtainable for good bricks in other places.

It may be generally stated that so far as the inferior or "Place" brick is concerned, the demand has been always supplied from home sources, but it is when the "Facing" brick is in question that the lamentable want of enterprise on the part of Irish manufacturers becomes apparent. Indeed we need not pass the City of Dublin to see how our brickmaking industries have decayed in late years. Formerly the best streets were built exclusively of brick, burnt in close proximity to the city; and many bricklayers remember when no foreign brick was imported. Whilst, on the other hand, the houses in the more modern townships which have sprung up around Dublin during the past 30 years are almost exclusively faced with Bridgwater bricks, roofed with Welsh slates, and floored with Baltic deals; whilst the blue or white ornamental brick which generally plays an important part, as well as the coarse flue lining, and glazed sewage pipe, are imported from Scotland or Cheshire. After this unpleasant retrospect, it is agreeable to find that there are some exceptions in Ireland: the most important one being in Belfast, where bricks of a very superior class have long been made and used in the erection of most of the magnificent buildings, largely or entirely composed of brick, which are a prominent feature of that town.

Within the past few years, however, a great improvement has taken place in the Irish-made bricks put on the Dublin market; and it is gratifying to state that the manufacturers' efforts have not been unappreciated, most of the brick buildings erected of late having been built of them. Comparing most favourably, both as to solidity and appearance, with the imported article heretofore employed, it is to be hoped that the enterprises now being so energetically carried on at Kingscourt, Kill-o'-the-Grange, Harold's-cross, and other places, will lead to the opening of works of a similar nature in many districts hereinafter referred to, where material of a likely character exists, and that ere long, at least, the Irish demand for the various descriptions of brick will be supplied from home sources.

Much will, of course, depend upon causes more or less apart from control of either the manufacturer or the buyer, foremost amongst which may be mentioned the rates of carriage, where it may be necessary to either transport the bricks from a distance to a good market, or to bring the fuel necessary to the fields. The railway rates are undoubtedly in many instances prohibitory to the development of the brick and slate trade, amongst many others; and it is to be hoped that steps will be taken to remove such a detrimental obstacle to the progress of a revival of Irish trade—a change which could not but be beneficial to the railway companies equally with the manufacturers.

A perusal of the evidence on this subject, given before the Parliamentary Committee on Irish Industries during the Session of 1885, would be interesting and instructive.

POTTERY, FIRE-CLAY GOODS, ETC.—As with the slates and bricks, so also with this very important class of goods, an abundance of suitable material lies in this country, but, with few exceptions, it remains undeveloped; and the goods of Stafford, Chester, and Glasgow supply the wants of even the most remote districts in Ireland.

As previously mentioned, the manufacture of pottery dates in Ireland from a very early period, and must have been extensively carried on judging by the abundance of the remains of sepulchral urns, cooking utensils, &c., met with.

The potters' trade, if it did not die out all together, at all events did not flourish or improve with the times, as already pointed

out. Gerrard Boate mentions that "a great number of English potters in several parts of the land had set up their trade, so as all kind of earthenware was very common, and was to be had at very easy rates." But in recent times the principal use of the Irish clays was to export them to England for manufacture into the various descriptions of pottery, some of which, it is probable, found its way back to the locality from which the raw material was derived.

The manufacture of tobacco-pipes was, some forty years ago, a familiar industry in numerous places throughout this country, but is now confined to a few localities only. In and about the city of Dublin a very common article are the small pipes, popularly known as "Dane's pipes," which are often found in abundance during the progress of excavations. It is questionable where they were manufactured. From the immense quantities of their remains which occur in some localities it would at first appear probable that they had been made in the district; but Dr. William Frazer, than whom there is no better authority on matters of antiquarian research relative to Dublin, having taken much trouble to investigate the matter, is of opinion that they were imported from England and that the large quantities of them often met with occur near the sites of former fairs, taverns, or similar places of public resort. In connexion, however, with this opinion, it may be of interest to note that during the cutting of the Waterloo and other roads in Baggot-rath, near Dublin, an immense number of those pipes were found in heaps, as well as spread over a large area, and which, from their unfinished and damaged appearance, strongly resembled the *debris* to be met with in connexion with modern pipe-kilns.

It is encouraging to be able to state that during the past few years some improvement has taken place in the prospects of the Irish delf trade. Excellent work has been turned out from the few manufactories which now exist. It is unnecessary to speak here of the reputation which has been obtained by one firm in particular, viz. the Belleek Company, whose goods have established themselves so well on the Continental and American markets. Suffice it to say that a large percentage of their output of the finer descriptions of pottery is bought up for the markets just referred to. The success of this enterprise, which labours under many disadvantages on account of position and other causes, should encourage the

promotion of pottery-making in many other districts where it would be likely to prove remunerative, as even the supplying of a small portion of the home trade would necessitate a very large make.

The manufacture of the common red ware, such as flower-pots, tiles, and similar articles, is of very general occurrence throughout the country. About the year 1850 this trade received a great impetus, and many new works were started to supply the existing demand for drainage-pipes, in consequence of the active drainage operations which were then carried on.

Fireclay ware comes principally from abroad, few manufactories for its production being now in existence in this country. This is much to be regretted, as there is a large supply of excellent material available, the utilization of which is very desirable, and would be likely to prove remunerative.

Many of the localities mentioned hereafter offer every inducement to industrial enterprise. It is true, indeed, that the present time does not seem to be an encouraging one in face of existing prices; but it is probable that these have reached their lowest ebb. However, the immense amount of goods for building purposes yearly imported suggests the natural inquiry as to why native materials, perfectly suitable for such purposes, have been so long allowed to lie unused; and it is for those within whose province it lies to make some effort to infuse a more active spirit of trade, always, however, bearing in mind that no mere sentimental support will carry them through to a successful end; but that the work must be prosecuted on a sound commercial basis, of a pecuniary return on the capital invested; and against the attainment of such result, should the subject be properly taken up, there appears to be no hindrance. (*R. Clark.*)

PART I.—SLATES.

From the argillaceous rocks are procured *Roofing slates* and *Slates suitable for walling purposes*. Some of the latter are eminently adapted for the uses to which they have been put, as men-

tioned hereafter ; some of the structures built with them being both elegant and durable.

Most of the roofing slates are heavier than the English slates in the market—this being due, in some measure, to the comparative shallowness of the Irish quarries. It is well known that the deeper the working the better the slate. For roofs in exposed places heavy slates are better than light ones, as the latter would be carried away by the wind. For this reason, in many places in Donegal, Mayo, Galway, &c., thin flags are preferred on account of their weight.

The best Irish slates occur principally in the "Slate Series," or Upper division of the *Ordovicians* ; nevertheless very good slates have been worked in the *Cambrians*, other parts of the *Silurians*, *Devonians*, *Carboniferous slates* ; inferior ones have been obtained from the *Coal-measures*.

The Irish slate quarries have been usually more or less injured by their being injudiciously laid out and opened ; the waste is often allowed to accumulate at the mouth of the working on the vein ; and as the quarry is extended the heaps have to be removed at great cost. Moreover, during the working, the waste is often thrown into the worked portion of the quarry, from which it has to be removed afterwards, if the vein is followed in depth. In many cases landlords have prevented quarries from being worked by asking too high royalties.

The following seem to be the principal slate-quarries which have been, or are now being, worked :—

- CLARE, *Broadford*, a good slate, once largely worked ;
quarries north of *Killaloe*, to the west of
Lough Derg, p. 336.
- CORK, *Glentane*, near Mallow ; *Audley Cove*, near
Ballydehob ; *Sherkin Island*, Baltimore
Harbour ; *Benduff*, near Rosscarbery,
p. 337.
- DONEGAL, *Glentown*, near St. Johnstown, p. 339.
- DOWN, *Tullycavan*, near Newtownards, p. 341.
- KERRY, *Valentia*, famous for its large slabs, p. 342.
- KILKENNY, " *Ormond Quarry*," *Valley of the Liffgaun*, near
Carrick-on-Suir, p. 343.

- LIMERICK, . . . *Ahaphuca*, S.S.W. of Ballylanders.
 TIPPERARY, . . . *Victoria Quarries, Valley of the Lingaun*, near Carrick-on-Suir; *Vale of Aherlow*, near Caher; *Corbally and neighbouring quarries*, near Killaloe, to the east of Lough Derg, p. 346.
 WATERFORD, . . . *Ross*, near Kilmaethomas; *Glenpatrick*, near Clonmel and Carrick; *Clashmore*, near Youghal, p. 349.
 WEXFORD, . . . *Newtownbarry*, p. 350.
 WICKLOW, . . . *Ashford*, p. 351.

ROOFING SLATES.

CLARE.

To the west of the south arm of Lough Derg there is a tract of the upper division of the *Ordovicians*, similar to those in which the Killaloe (*Corbally*) slate quarry is situated; but the slates in general do not appear to be comparable either as to quantity or quality.

At Trough, about four miles north of Limerick, slate was quarried to a slight extent, but as it was coarse and heavy, the works were abandoned, as were also others in this range of hills.

To the N. E., in Slieve Bernagh, or the group of hills about Broadford and Killaloe, slate veins have been opened in several places between *Huddlestown* and *Broadford*, and at *Knockprise*. The slate was good; but as it was greatly ruptured by faults, no large working could be carried on, the slate occurring in small patches, locally called "pockets."

In the hills south of Glenomra, the valley between Broadford and Killaloe, various trials were made without good success, although for a time a coarse slate was worked a mile S. W. of Kilbane.

To the east of Broadford there is an apparently good vein, which at one time was rather extensively worked; but the long and expensive land carriage to a market seems to have stopped the work. Farther eastward, north of Glenomra, and near Lough

Derg, in *Craglee*, trials have been made, and in a few places slate has been worked to a slight extent.

In the west part of the county the shales in the *Coal-measures* between Kilkee and Miltown Malbay are cleaved, and in places have been worked for roofing slate.

CORK.

In this county good slates occur in the *Silurian* (?), the *Devonian*, the *Yellow Sandstone*, and the *Carboniferous slate*. Lewis mentions the following quarries in 1835 :—

Prohust and *Glentane*, respectively, N. W. and S. W. of Mallow, “the latter producing slate of superior quality”; *Ringabella* (Cork Harbour), “a slate quarry badly worked”; *Enniscarra*, S. W. of Cork; *Kilbrittan*, S. E. of Bandon, “a good slate quarry”; *Bracknagh*, about eight miles W. S. W. of Bandon, “good slate quarries”; *Enniskeen*, west of Bandon; *Mohanagh*, near Dunmanway; *Rooska*, north shore of Bantry Bay, about sixteen miles from Berehaven, “an extensive quarry”; *Audley Cove* and *Tilemuck*, Ballydehob, “opened by the West Cork Mining Co., who, in 1834, had 500 hands employed. The slate was of good quality, hard, compact, durable, and had a ready sale in London and other English markets”; *Sherkin Island*, Baltimore Harbour, “an excellent reddish, hard, and durable slate”; in 1835 there were 100 hands employed, and many cargoes were shipped to England, where they had a ready sale”; near *Clonakilty Bay*, blue slate; *Templemalus*, Clonakilty Bay, “good slate”; *Forkhill*, N. E. of Clonakilty, “excellent slate”; *Donaghmore*, seven miles S. S. E. of Clonakilty, “quarry of excellent slate”; W. S. W. of *Kinsale*, “some quarries of excellent slate”; *Robert’s Cove*, parish of Ballyfoil, ten miles N. E. of Kinsale, “valuable slate quarry; the slates were formerly exported in the ships that brought coal to the bay”; *Trabolgan*, about six miles S. W. of Cloyne; in 1835 there was “a valuable and extensive quarry of good, durable, and well-coloured slate, employing a good number of workmen”; *Carrigduff*, southward of Mallow, rough slates; *Derrygool*.

In some of those places mentioned by Lewis the slates are undoubtedly good, and might be easily and cheaply worked, while there are great facilities for shipping them to any market; yet

since his time very little has been done. The Devonian slates of green and red colours, that ought to be valuable for ornamental purposes, have been very little used. These usually occur on a well-marked horizon, at the junction of the Yellow and Old Red Sandstones. At *Browhead mine*, and between Horseshoe Harbour and Barrackpoint, they were worked for local purposes. The slate at the S. E. corner of *Sherkin Island*, Baltimore Harbour, has been highly approved of, and sometime since a Company was formed to work this vein; but for some unknown reason the enterprise was abandoned. At Cappoge, west shore of Roaring Water Bay, there is a purplish blue slate well suited for slabs. In different other places the slate veins have been opened for local purposes; but more often to obtain slabs than roofing slates.

The Carboniferous dark-grey and blackish slates have been more worked of late years than the others. One quarry is at *Rossmore*, about a mile W. S. W. of Fourmile Water; farther south westward, near Kilcrohane, there are quarries in the townlands of *Gortakilly*, *Gouladoo*, and *Foilkilly*, the slate being of better quality than at Rossmore, besides being near a harbour; these slates have been worked only for local purposes. Grey slate has also been worked N. W. of *Dromdaleague*, *Curraghlicky*, *Enniskeen*, *Bandon*, and *Clonakilly*; but the most extensive quarry from which slates are exported is at *Benduff*, two miles N. W. of Rosscarbery, on the road to Leap. Here the vein is about seventy yards wide, and of a very dark-grey colour. In places in the slate there are small specks and veins of pyrites (rucks), nodules (bulls' eyes), and a curled structure in lines called *cullheads*; all of which, when they occur, deteriorate the slate. Slabs for flagging have also been raised here, and were used in Skibbereen and elsewhere.

DONEGAL.

In this county there have been many trials for slate, but only in a very few places is the quality and quantity sufficient to make it worth while opening a quarry. The following is a list of the principal places:—

Dunwiley, a mile and a-half from Stranorlar; half a mile from *Letterkenny*, and about the same distance from Lough Swilly;

Thorn, eastward of Letterkenny; between Dunfanaghy and Falcarragh (Cross-roads), a heavy slate, quarried in different places for local purposes; near *Milford*; *Strawbridge*, four miles from Carndonagh; *Carrickmacrolly*, nine miles from Carndonagh; *Dunmore*, nine miles from Carndonagh; *Buncrana*; *Fahan Point*. In all these places there have only been trials made, or very small quarries opened.

On the shore of Lough Swilly, at Saltpans, to the north of Rathmullen, there is a vein of good-looking slate.

In the country west of Lough Swilly there are numerous bedded sheets of whinstone, which have baked the associated shales; and some of these baked rocks are good novaculites or honestones. A good vein occurs west of Oughterlinn R. C. Church, north of Lough Swilly.

Glentown quarry, about two miles west of St. Johnstown. In this neighbourhood there appears to be two or more veins of slate, which have been holed in places. Tradition has it that slates have been procured here for about 100 years, the oldest working being about a quarter of a mile N.E. of the present quarry. They are mentioned by Dr. McFarlane, who wrote in the beginning of the century. The main vein is from twenty to thirty feet wide, and ranges about N. 60° E., dipping northward at from 50° to 70°, the cleavage striking N. 20° W., and having E. at about 55°. For a length of over a quarter of a mile there are old openings along its out-crop; while to the eastward, at the margin of the drift slope, a deep quarry was opened some fifty or sixty years ago by a Mr. Alexander, who raised the stuff, waste, and water by an engine. About forty years ago (say 1845) it fell into the hands of the landlord, the Marquess (afterwards Duke) of Abercorn, who, at a cost of £2000, ran in a tunnel, from the valley on the east, 380 yards long, which cut the vein eighty-four feet below the surface. This tunnel drained the workings, besides being used as a tramway, by which the stuff and rubbish was removed. Subsequently the vein was wrought for about 400 yards to the level of the tunnel, while at the eastern end it was further worked for a depth of forty feet below that level. The works were continued to the year 1879, when, on account of the depression in trade, they ceased to pay, and had to be abandoned. At that time from twenty to thirty hands were employed making the slates, all of

whom were from the neighbourhood, and had learned the trade when children.

The slate is very good "metal," of a darkish-grey colour, which is permanent, as can be seen in the roofs of the neighbouring houses. The slate seems to be durable, and as it is light, the roofs require timber of but small scantling. As in other slate veins, the stuff improves in quality in depth, but at the same time it is remarkable what good metal can be procured close to the surface. The vein, however, is crossed by numerous joints, which prevent the slates being raised of large dimensions, the slate, as seen in the roofs of the houses, being about 18 to 24 inches long, and from 4 to 12 inches wide; but the better and larger slates were exported to Glasgow, and their dimensions could not be satisfactorily ascertained. The joints in the upper portion are said to have continued down as deep as the slate was followed. Only roofing slates appear to have been wrought. They were brought to a yard at the mouth of the tunnel, and there sold, either for local use, or to be shipped to Derry, Strabane, or Glasgow, from St. Johnstown.

The work does not seem to have been very judiciously planned, as the waste, instead of being run out of the quarry by the tunnel, was run into the deep working, and when operations are resumed, it will have to be lifted and removed at considerable expense. An apparently advantageous method of using this quarry would be to remove all the *debris* of the ancient working, and any bad stuff on the back of the vein, into the valley to the westward, and from the brow at the west to carry a-breast eastward. This would leave the vein clear, so that all that would afterwards have to be carried through the tunnel would be the workable stuff, and a small percentage of waste. The removal of the back of the vein would not be altogether unprofitable, on account of the good quality of some of the surface-stone, which could be wrought into slates.

DOWN.

Prior to 1837, as mentioned by Lewis in his *Topographical Dictionary of Ireland*, there were many trials made, or small quarries opened, for roofing slate, none of which have since become of importance. He states that the Co. Down slates "are inferior

to those of Bangor (in Wales) in colour and lightness, but superior in durability." They are of *Ordovician* age.

Aghaderg parish (Scarva), quarries in places worked prior to 1837; *Cloontogh* (parish of Annahilt), E. S. E. of Hillsborough, "fine slate quarry"; *Bangor*; *Donaghadee*, vein wrought only on the surface where the slates are inferior, though better in depth"; *Tullycavan* (parish of Grey Abbey), S. E. of Newtownards, "an excellent slate, but the quarry is worked injudiciously"; *Lough-inisk*, west of Downpatrick; *Ballynacrag*, near Strangford Lough; near *Ballinahinch*; Ballyloe; *Ballyahcood*, between Bangor and Ballywalter; *Carngarva*, S. W. of Conbiggs Hill; *Mourne Mountains*, small quarries in different places on the lower slopes.

DUBLIN.

The slates that occur in this county (page 356) seem not suitable for roofing purposes.

[Quotation.—*Killaloe*, 16" × 8" — 16" × 10" — 20" × 10" — 22" × 11" — 24" × 12" — Prices about 20 per cent. less than the Welsh; but they have not a great demand, in consequence of being so heavy. A good wearing slate; freight about 5s. per ton.

Present (December, 1887) prices Welsh slates—best blue *Bangor*, Queens, 85s. per ton; 24" × 14", £13 10s. per 1200; 24" × 12", £11 5s. per 1200; 22" × 12", £9 5s. per 1200. *Port Madoe*, 24" × 14"; first quality, £11 10s. per 1200; second quality, £10 5s. per 1200.

American and Italian slates were in the market some five years ago, and were in use, but are now quite gone out, in consequence of the Welsh men lowering their prices. Both kinds changed colour on the roof, the Italians becoming quite white.]

FERMANAGH.

In the *Ordovician* rocks, north of Lisbellaw, there is a slate vein that has been worked a little; the slate, however, is of poor quality.

GALWAY.

As yet no vein of good roofing slate has been proved in this county. In the *Silurians*, at Gowlane, north of Letterfrack, there is a kind slate, but it is, unfortunately, so full of joints that it splits up into small pieces. To the north-east, north of Lough Muck, a green slate has been worked; but it is too heavy, except as slabs for flagging purposes. Still further north, at Salrock farmyard,

there is an untried, good-looking vein of reddish-purple slate. There are also in the valley, between Leenaun and Maum, and in the hills to the eastward, fair-looking red and bluish-grey slates.

KERRY.

In Valentia Island, on the eastern slope of Geokaun, a quarry was opened by the Knight of Kerry in 1816, and he continued to work it, principally for roofing slates, till 1825, when it was taken by the Irish Mining Company, who worked it for only about six years. It was then taken up again by the Knight of Kerry and worked by him till 1839, in which year it was taken by the *Valentia Flag Company*, and worked till about 1877, when it again fell into the hands of the Knight of Kerry (Sir Peter Fitzgerald, Bart.), who wrought it till his death in 1880.

The slate is not good for roofing purposes, as it is hard to split. The best roofing slates in the immediate neighbourhood are in a vein in the townland of Coole, and in another below high-water mark on the west side of Beginish, in Valentia Harbour. The latter can be worked only during low tides.

The roofing slates made at Geokaun had a good local sale, but could not compete in the open market with other slates. This, however, could not be said of the slabs, which are not to be excelled for beauty, strength, or size, and were largely exported to London, as also to America. The largest sizes for London averaged 14 feet by 6 feet but; some required of extra length were procured over 20 feet long. The Flag Company developed the trade, and for some years carried it on very successfully, until the Welsh slabs came into the market, which could be sold at lower prices, being an inferior softer slab, more easily sawn and planed, besides which for many purposes the small Welsh slabs answered as well as the larger from Valentia. The Valentia slabs sold for prices varying from 35s. to 55s. a ton, according to sizes; about 150 superficial feet an inch thick going to a ton.

In the quarry there are three slate-beds. The upper bed, which gives the best slabs, is about nine feet thick, and yields blocks 14 feet long, by various widths, the latter being due to vertical joints, which bear N. and S. (magnetic.) The middle bed is about 16

feet thick. It is of a softer nature, and is crossed by diagonal joints, which prevents the material being wrought economically into slabs; but it splits more easily than either of the others into roofing slates, and it is from it most of these were made. The lowest bed is about 14 feet thick. It is not as good for slabs as the upper one; but is better than the middle one, having fewer diagonal joints, so that in places good-sized blocks can be procured; whilst from the waste roofing slates were made. The quarry is a great cave in the face of the hill. It is remarkable that in the good veins of these *Silurian* slate the angle of the cleavage is always low, while in the best slate of *Ordovician* age the inclination is high, often vertical.

In Coole, which lies westward of the Geokaun quarry, there is a very good vein of slate, both for slabs and roofing purposes; it has been very little worked.

The vein of slate on Beginish has already been described.

On the mainland, near Cahirciveen, to the west of Ballycarbery Castle, some slates have been raised from a purple vein, while in the county to the eastward slate has been raised in the Lough Carra district, but not extensively. Small workings for local use are mentioned at page 357 when describing the slates used for walling purposes.

KILKENNY.

In the *Ordovician* rocks in the valley of the Lingaun, at the junction of Tipperary and Kilkenny, the Ormond quarries have been opened on slate veins. The slate is of excellent quality; but unfortunately near the river, where the quarries are situated, the strata are very much cut up and shifted by faults, which adds considerably to the working expenses, as the slate vein may be cut out when a quarry is in full working order. Farther away from the vein, in the hills, the veins seem to be much more continuous, and therefore more suitable for the site of a quarry; besides, on the hills the veins could be worked by a tunnel and level without the expense of the present lifting and pumping. These quarries used to supply a large quantity of slates.

The *Ormond Slate Quarries* are in the townlands of Knockroe and Mealoughmore, barony of Kells, Co. Kilkenny. The veins are

similar, and similarly circumstanced to those in the Co. Tipperary. (See *Victoria Slate Quarries*, under Tipperary, p. 346). But the quarries have not been so continuously or systematically worked, as they have passed through the hands of different companies and individuals.

Between Kilmaganny and Ballygowan a slate-vein was, at one time, worked; but the slates were considered too soft. At this place there is an excellent novaculite or honestone; it is soft, but capable of giving a fine and finished edge to tools; it is much used in the neighbourhood.—(G. S. M.)

Blessington, about a mile and a-half eastward of Thomastown; an untried vein of slate.

In the south-east of the county various trials have been made, but no satisfactory vein was discovered.

KING'S COUNTY.

The *Ordovician* slates appear only in the south-east of the county, to the southward of Kinnity; and various small openings have been made in different places; but none of any great extent. In general, the good veins appear to be of small dimensions and not worth quarrying.

LIMERICK.

Ordovician slates are found to the south of the county in the neighbourhoods of Kilfinane and Ballylanders, where there are several small quarries. Four miles S. S. W. of Ballylanders, in the Ahaphuca valley, on a vein of greenish-grey good slate, an extensive quarry has been opened; and a second on a similar slate to the east of Ballylanders, just outside the mearing of the county, in county Tipperary (page 346). These slates were at one time extensively used in all the neighbouring country; but now they are considered too heavy for ordinary roofing purposes.

Lewis mentions a "slate of good quality quarried in the immediate neighbourhood of *Kilmallock*; a vein south-east of *Houndscourt*, parish of Kilfynn; an inferior slate at *Towerlegan*; and a slate quarry at *Darragh*, south-east of *Kilfinane*."

LONDONDERRY.

In the parish of *Muff*, and in other places, there are green, chloritic, coarse slates (*Ordovician?*), which are used locally for roofing purposes.

LONGFORD.

Derrycrois, west of Granard, a good-looking slate; as yet untried.

LOUTH.

The greater portion of this county is occupied by *Ordovician* rocks, in which are different slate veins; but the products of these seem not to have been favourably received as roofing slate, although excellent for general building purposes (p. 359).

Near Mellifont the slates can be raised in large slabs, and some of them have also been used as roofing slates; but these are not much approved of, being too heavy; however, some of the veins in this neighbourhood, if worked on in depth, would doubtless improve greatly.

Creggan, W.N.W. of Dundalk, a coarse and heavy, but durable slate.

MAYO.

At *Lanmore*, between five and six miles south-east of Westport, there are dark-grey *Ordovician* slates, which have been quarried along the outcrop to supply roofing slates in Westport and that neighbourhood.

At *Derrygarve*, about six miles southward of Louisburg, there is a thin vein of a good bluish-grey slate of a fair quality, but of too small dimensions to be worth much. The slate is used in Louisburg.

Along the north shore of Killary Harbour there are also *Ordovician* slates to the east of Bundorragha. Some of them have a good appearance; but as yet no trials have been made.

Parish of *Kilfian*, west of Killala; in different places small quarries produce a coarse slate.

MEATH.

In this county there is a considerable area of *Ordovician* rocks; but in general the slates are hard and intractable, and not suitable even for ordinary building purposes, as in the neighbouring county of Louth.

MONAGHAN.

In *Criev Mountain* there are small slate quarries. Over the greater part of this county the rocks belong to the *Ordovicians*; but, as in Meath, the slates are hard and intractable.

QUEEN'S COUNTY.

S.W. of Mountrath, in Offerlane parish, there is a slate quarry, as also at Cappard, west of Mountmellick (*Lewis, Top. Dict.*).

SLIGO.

Trials for slate have been made at Kilmacshalgan, near Dromore West, but without success.

TIPPERARY.

In the south-eastern part of the county, in the valley of the Lingaun River, are the Victoria, or Clashnasmut quarries (*Kilkenny, ante*, p. 343).

The *Victoria Slate Quarries* are situated in the townland of Clashnasmut, barony of Slieveardagh, Co. Tipperary; they are six miles from the town of Carrick-on-Suir, and fourteen miles from Waterford.

The district in which these quarries are situated is thus described by the late Mr. Du Noyer:—"On the eastern side of Slievenaman Mountain, in the counties of Tipperary and Kilkenny, there is an elevated plateau formed of the Lower Palæozoic or Lower Silurian slates, with a few associated trappean beds, occupying a space of twelve miles from east to west, with an average width of three to five miles. This is completely surrounded by a barrier higher than itself, formed of Old Red Sandstone, the beds of which are uncon-

formable to the Silurian slates, and dip away from them on all sides, usually at high angles.

“The greater part of this plateau is drained from east to west by the river Lingaun, which joins the river Suir, close to the town of Carrick. Near the central portion of this plateau, between the villages of Windgap and Tinnakelly, the river Lingaun has cut a deep glen in the slate rocks, and here extensive quarrying for roofing slates has been carried on for many years, which include the open quarries of Clashnasmut and others.

“The average strike or direction of the slate veins in the Victoria Quarries is north-east and south-west, with rolling-dips at 60° to 70° , and as the general direction of the slaty cleavage which invariably pervades these rocks is 30° to 40° north of east, and south of west, vertical, the relation of the planes of dip and cleavage is most favourable for the development of the required slaty structure.

“The slates raised from this quarry are of a pale-grey colour, free from any iron pyrites; they are remarkable for their size, soundness and evenness of the cleavage, and for the ease and thinness with which they split. The quality of the slate is second to none in Ireland, and the quantity is practically inexhaustible.”

The present Company was incorporated in 1864, with a capital of £50,000, of which £40,000 has been already spent in developing the resources of the quarries; various causes have delayed the full opening of this property, the present annual raisings from which are of the value of from £6000 to £7000. The slates are in steady demand.

On one portion of the property, where the slate rock comes into contact with the Old Red Sandstone, the slate is of a greenish hue—a colour in great request for ornamental roofing. This slate was awarded a gold medal at the last Dublin Exhibition (1882), and a large bronze medal “for its colour, strength, grain, and texture” at the Cork Exhibition (1883). The rock is cut and dressed by machinery, the motive power being supplied by the river Lingaun.

In the Galtymore range, in the south-west of the county, and near the mearing of the Co. Limerick, is the already mentioned (Limerick, *ante*, p. 344) large quarry in the southern side of the Glen of Aherlow, one and a-half miles south of Ballynacourty, or New

Forest House. The slate is of a greenish colour, and very good, but heavy. It has been extensively used for the roofing of the neighbouring mansions, farm-houses, and buildings. The slate has been tried again of late years, but only a narrow portion of the vein formerly worked was found capable of producing slates light enough for the present market. To the south of the quarry there is a vein of good appearance not as yet tried.

About seven miles or so N.N.E. of Killaloe are the quarries called after that town.

Killaloe Slate Quarry.—The quarry to which this name is now almost solely applied is at *Corbally*, near the village of Portroe. In the vein there appears to be here a nearly inexhaustible supply of excellent slate; but the quarry was badly laid out originally, and is too confined to be worked to the best advantage; and a great deal that ought to be profit is spent in raising the slate, rubbish, and water out of the quarry, which is large and deep.

This quarry was first opened, about the year 1826, by the Mining Company of Ireland, who worked it till about 1841, when it was bought by the Imperial Mining Company, who were working quarries in the vicinity. Besides roofing slates, the latter Company manufactured slabs for flooring, steps, window-sills, &c. Under these Companies the quarry does not appear to have been very profitable. It eventually, however, fell into the hands of Mr. Headach, who was very successful, and in the end sold it to the Killaloe Slate Company, who are now working it. There is a ready sale for all the slates that can be made, but, unfortunately, on account of the peculiar contracted condition of the quarry, the output is much less than it ought to be.

To put the quarry into a condition so that it could be worked to the best advantage would require a considerable immediate outlay; but this would be vastly more than compensated for hereafter by the saving of working expenses and the much larger annual sales.

The width of the slate vein is over 400 feet. It is divided into sub-veins, some with a ribbon (*cleaved shale*), and some without (*cleaved clay-rock*), which average in width from fifteen to twenty feet. The latter are the more profitable, as they split more easily; besides which they have horizontal joints (*soles*), which facilitate the working of the veins. The soles are greatly prized by the

quarry men, as without them there would be a considerable loss from the waste of good material in getting out the blocks.

Other quarries in this vicinity are—that at *Laghtea*, about two miles S.W. of Portroe, in which there appears to be a good small vein; two small quarries, north of Tountinna, near the “graves of the Leinster men”; *The Gap*, which lies a little east of the last; *Derry Castle*, a large quarry worked by the “Imperial Company:” there is said to be in these slates a “wind,” in consequence of which they are liable to cast up; it was for this reason that the Company purchased the Corbally quarry; a quarry one mile south of Derry Castle; and a quarry half a mile N.W. of Ballina. In the last the slate is of a very superior quality, but it has an off-baring of twenty feet in thickness, of a massive green grit, which made the slate very expensive to work. Other small openings were made in this vicinity; but the slate was not of much value, as regards either quantity or quality.

TYRONE.

North-east of Pomeroy, at the village of *Slate Quarry*, roofing slates were formerly obtained, but they were poor, being small, heavy, and rough.

WATERFORD.

Four and a-half miles east of Kilmacthomas are the *Ross quarries*, which were worked up to 1863; the slate is good, of a dark-grey colour.

In *Glenpatrick*, six miles from both Carrick and Clonmel, there were, before 1850, rather extensive quarries on veins of *Ordovician* slate. The largest are *Toor*, to the north, and a quarry 300 yards to the south of Glenpatrick bridge. In the former the slate is fine-grained, of a bright bluish-grey, and in the latter of a lighter grey. The veins in both are of a good width.

A third quarry is situated in Clondonnell, at the base of the Reeks of Glenpatrick, on a vein of finely-cleaved, earthy, grey slate.

The slates in this glen seem well worthy of being re-worked, more especially on account of the nearness of the river Suir, which is there navigable for boats; but they ought to be worked on better principles than formerly.

Ordovician slates was also worked in the south-west part of Lisnadill parish.

In the *Devonians* a red bed was considerably worked near *Clashmore*, in the valley of the Lickey. In places in the vicinity of *Lismore* slates of this age were also worked, the quarries being more fully described hereafter; also in *Glenribbon*, north of the Blackwater, and on the slopes of *Knockmealdown*; the slate was of good quality, but the veins of small dimensions.

WEXFORD.

In the *Cambrians* of the Forth Mountains, about a mile east of Trinity cross-roads, a nice-looking blueish-grey slate is recorded; but it is as yet untried.—(G. S. M.)

In the *Ordovicians*, a mile and a-half S.S. W. of Bunclody, or Newtownbarry, in the townland of *Ballyprekas* (Hall-Dare), and *Glaslacken* (Digby), north and south of a glen, slates are found. The veins are peculiar; because, although the quarries are opposite one another, and seem to strike one at the other, the slabs are quite different; those to the north, in the Hall-Dare quarry, being blue and ribboned, while those to the south, in the Digby quarry, are grey or greenish grey; a grey vein in the latter is of excellent quality.

At the present time these quarries are smothered up, and are only worked in a very small way; yet there are great facilities for opening a good quarry—that is if a deep cutting was made up the glen from the westward, by means of which the veins would be drained to a considerable depth, while the waste could be run out into the valley to the westward and the veins both to the north and south economically worked.

In Slievebawn, the hill about five miles north-west of Gorey, and immediately westward of Hollyford, there are considerable veins of slate. To the westward, near *Monaseed*, there are various small workings; and although none of them are deep or of great extent, yet a very fair slate has been procured, with every prospect of a superior slate in depth. The veins could be easily driven on, either from the eastward or westward, and the opening and working of a quarry ought not to be expensive.

A fair slate was worked a little at Killybeg, four miles from Enniscorthy; while trials were made on the eastern slopes of Mount Leinster.

WICKLOW.

In the north-west of this county, a few miles north of *Blessington*, near the mearing of county Kildare, a slate vein was worked in the *Ordovicians* about the middle of the eighteenth century. Jukes states:—"The cleavage is often as fine and complete as in any slate whatever; and it only fails to make good roofing slates from the want of firmness in the materials." It was formerly much worked for small slates, but to no great depth; and it is possible that if it were sunk on, in depth, the size and quality of the slate would improve.—(G. S. M.)

Near *Ashford*, in the Devil's Glen, a slate was being worked in the year 1845, both for roofing slate and slabs. Both Kane and Wilkinson write approving of it, and state that it has a very strong resemblance to the Welsh slate, both in colour and in texture, being about intermediate in character between those of Bangor and Llanberis; while, like those veins, it is of *Cambrian* age. This quarry appears to have been worked for a few years with every prospect of success, turning out good work in roofing slates and slabs; but the proprietor, like many others, suffered from the great depression in trade of 1850 and subsequent years, during which the works were abandoned.

In different places south and south-east of Rathdrum there have been trials, or small workings, on *Ordovician* slates; those in *Kilmacrea* Hills, north of Redcross, were the most extensive, and good slate was procured near the north part of the Pass; but the veins are narrow, so that there is no opportunity for a large quarry.

At *Clanwilliam*, a little south of Wooden Bridge, in the *Ordovicians*, there is a small quarry which was lately worked principally for the manufacture of "school slates," as the slate is not very good for roofing purposes. In the opposite brow, to the east of the valley, there appears to be a better vein of roofing slate. The colour varies, the slate being greyish green, bright green and purplish. These veins have not as yet got a fair trial, as the works were injudiciously laid out.

Westward of Wooden Bridge, both north and south of the Darragh Water, or Aughrim River, there is a vein easily wrought into large slabs. This has been worked a little for tombstones.

In the southern part of the county, a little north of Carnew, are the *Kilcavan slate quarries*. Here the veins are peculiar, as they swell out and contract suddenly; while in the vein a mass of grit may appear cutting out the slate. The slate is of a dark colour and fair quality; but the quarry has been greatly injured by allowing the rubbish to accumulate in it, and at its mouth; and now before it could be worked this would have to be cleared away at considerable expense.

About two miles from Rathdrum there is a slaty flag that has been used in the town.

Lewis mentions "quarries of good slate at *Crehelp*, three or four miles east of Dunlavin, and a slate quarry, opened about the year 1830, at *Gibbet Hill*, near Clonegal.

SLATES USED AS BUILDING-STONE.

ANTRIM.

In the north-east of this county there is a small tract of more or less metamorphosed rocks, probably the equivalents of either the *Ordovician* or *Arenig*. The schists and slates are locally used for common walling purposes.

ARMAGH.

In Armagh, extending north-eastward and south-westward into the adjoining counties of Down and Monaghan, respectively, is a large area occupied by *Ordovician* rocks, in which slates largely occur. Here, as in the rest of these *Ordovicians*, they are the general building-stone of the country, being preferred to the associated grits; but they are not suited for cut-stone purposes. At Carricklane there is a quarry of good stone that was used for walling in the building of Gosford Castle.

CARLOW.

The slate rocks of this county are of very little importance. *Ordovicians* occur only in the south-east of the county in the neigh-

bourhood of Clonegall and Kildavin, where they are more or less metamorphosed; the slates and schists are locally used for common walling purposes. In the south-west of the county, in the *Coal-measures*, there are shales, but they are usually too friable or soft to be much used, except for road-mending.

CAVAN.

The south-western end of the tract of *Ordovicians*, mentioned under Armagh, occupies a considerable portion of this county; and in the towns situated thereon, as Cootehill, Ballyhaise, Bailieborough, Virginia, Ballyjamesduff, and others, slate is principally used for ordinary walling, sandstones usually being used for quoins and dressings; some few of the slate rocks, however, from deep quarries, can be turned out as quoins. The slates vary very much from gritty to fine and soft; some of the best class occur near Cootehill. In the north-west of the county there are *Coal-measure* shales; these are usually soft, and not much used, the associated grits and flags being preferred.

CLARE.

In the east of the county are more or less small isolated exposures of *Ordovicians*. In these and in the marginal tracts of *Lower Carboniferous*, and in the *Coal-measures*, in the west of the county, are slates and shales, which are locally used for building purposes, such as bridges, farm-houses, and fences. In the *Coal-measures*, between Kilkee and Miltown Malbay, the slate is better than ordinary, and splits easily, so much so that it has been used in places for roofing slate (*ante*, p. 337).

CORK.

For building purposes, both in old and modern times, slate-rocks have been more used in the Co. Cork than perhaps any other county in Ireland—as in Bantry, Skibbereen, Dunmanway, Bandon, and Kinsale.

At *Bantry* is the Seskin quarry, where most of the stones used in building the town were procured. Usually it is a greyish gritty stone; but there are subordinate beds of purer slate which are

wrought into window-sills, steps, quoins, &c., and appear durable if set on edge. When the Union Workhouse was being erected, about 1830, they came on a peculiar arch in this quarry, which has been figured and described by Wilkinson. It had a distinct arched form among the vertical strata, both above and below it. The face of the arch to the east, when first met with, was smooth from springing to springing, being about thirty-four feet wide, and narrowing gradually as it was followed westward to about twenty feet in a length of 120 feet. The vertical strata "abutting close under its soffit, and forming abutments to the springing of the arch The greater number of the ring-stones of the arches of the building (Union Workhouse) were procured from this vein, as also many fine quoins, &c. Many of the stones taken from the rings were used in arched portions, in the state already prepared by the hand of Nature."

At *Rushnacara*, north-west of Dunmanus Bay, and sixteen miles from Bantry, a green and grey slate-rock was used in the building of the National Schools. It is very durable, and can be raised in large scantlings; but is only fit for rubble work.

In the neighbourhood of *Skibbereen* the slate is greyish and reddish brown. It is often mixed with a scaly quartzose rock, which adds to the cost of quarrying.

Near *Dunmanway*, the stone which seems to be most preferred is a hard, gritty slate, but abounding in good natural joints, which make it easily quarried in suitable sizes; the more slaty, or argillaceous, rocks are less used.

In the vicinity of *Enniskeen* is Kinneigh round tower, a good example of slate work. The stone used in this tower, which abounds in the neighbourhood "is well worked and is closely dressed on the edges of the beds, both in the circular work of the upper walls and in the splayed angles of the lower portions of the tower. The stones used vary in length from one to nearly five feet, and in thickness from three to twelve inches, and the material appears durable." (*Wilkinson.*)

The Abbey of Timoleague is also a good example of slate building. It is of Early English architecture, and illustrates the good quality of the slate rock of the locality, "and the simple and proper mode of using it; the design and constructive arrangements being suited to the materials employed." (*Wilkinson.*)

In the neighbourhood of *Bandon* the slate rock is a good building stone; for, although finely cleaved, some veins being wrought into roofing slate, it can be worked freely across the edges. It seems to have been more used in old times than at present, as now limestone is often preferred.

In the *Kinsale* district the slates are of a bad description; but at a few miles' distance there are greenish slaty rocks, suitable for rubble work, while sandstone or limestone are used for the dressings.

DONEGAL.

More or less metamorphosed rocks of the *Cambrian*, *Arenig*, *Ordovician*, and *Llandovery* formations occupy the greater part of this county.¹

In the less altered parts the slates and schists are used for local building purposes; but none of them are suitable for out-stone. From some beds margining the gneiss on the southward, between *Lough Salt*, to the eastward, and *Glendowan*, to the westward, good purple micalyte flags of fair sizes can be procured in the strip margining the foliated Granite and Gneiss. A little S.W. of *Kindrum* (*Fanad-Within-the-Waters*) are good felspathic schist flags, which can be raised of large dimensions. Thin-bedded flags occur to the eastward in several places in the neighbourhood of *Lough Swilly*, a very good vein occurring at *Saltpane*, which has been quarried a little for eave courses and quoins. As already mentioned, in different places in the county trials have been made for roofing slates.

DOWN.

Occupying a considerable part of this county is the north-east portion of the large area of *Ordovicians*, already mentioned in connexion with the counties of *Armagh* and *Cavan*. Here, as there, are different varieties, which are very generally used for rubble work and ordinary walling, while granite in the south portion of the county, and freestone in the north part, are used for cut work and dressings.

¹ *Vide* this Journal, vol. viii., p. 246.

DUBLIN.

The slate rocks, when they occur in the north portion of the county, at *Houth*, and to the southward, bordering Wicklow, are employed for common building purposes; but in general they are not used as they might be, bricks being greatly run after in many places. Bricks are more economical for finer kinds of work; as although the slate may be easily and cheaply procured, the mortar working and setting, which is necessary to make neat masonry of it renders it more expensive than brick.

FERMANAGH.

Metamorphosed *Ordovician*, *Arenig* (?), or *Cambrian* (?) rocks occupy a small area near Pettigoe and Belleek, at the north-west of the county, and a smaller one to the north-east, at Lack; and the slates and schists in these are locally used for common walling purposes.

In the *Slievebeagh Series* (Carboniferous, *vide* SANDS and SANDSTONES, page 222), in the south-east of the county, in the different tracts of *Calp* and *Coal-measures*, there are shales; but these are only very locally used.

GALWAY.

In Yar Connaught, or the country west of Loughs Mask and Corrib, many of the rocks are of slaty character, but usually metamorphosed into micalyte or allied schists. The probable ages (*Ordovician*, *Arenig*, and *Cambrian* (?)) of these rocks have already been discussed (SANDS and SANDSTONES, page 215). Over these, to the north, and extending into the county Mayo, are slaty rocks of *Silurian* age, while margining these and the older metamorphic rocks are the *Lower Carboniferous*. The slate rocks that occur in these different geological groups are more or less locally used for common walling purposes; but there is no very great demand for them anywhere, the villages and hamlets being few and far between; and the stones required are procured on the surface of the ground, or any place where they will cost least in the getting. In building Kylemore Castle, in the north of the county, the stone for general walling purposes was blasted out of the site to be

occupied by the castle. It constitutes good and apparently durable work, the dressings and facings being of granite from Bullock, Co. Dublin. This seems to be the only large modern structure in which slate rock has been extensively used, and the result shows that it is very suitable for such work.

KERRY.

The slate rocks of this county are of good and durable material. They nearly always dress well on the bedding surfaces, and if sawn across the grain, and moulded by planing, they would be capable of being used for nearly any purpose, as exemplified in the slate quarries of the Knight of Kerry, Valentia. In different places, on account of the low dip of the strata, and the water-power nearly everywhere available, there would be great facilities for outting the rocks *in situ* into any scantlings, by machinery, in the quarries. This, however, has not as yet been adopted in Ireland; although, as previously pointed out (MARBLES and LIMESTONES, page 200, and SAND and SANDSTONES, page 212), it might in places be advantageously introduced.

The slate rocks are eminently suitable for dry masonry, as exemplified in many of the modern, and in the ancient erections, such as the forts at Ballycarbery, near Cahirciveen, and those of Derrynane and Staigue, as also the forts and bee-hive houses (*cloughauns*) of the ancient settlement, called by Du Noyer the "city of Faha," in the Dingle promontory.

In the *Devonian* and *Silurian* areas the slate rocks are preferred to any others for general building purposes; at *Tarbert* and *Killarney* gritty varieties being principally used.

— [The slate and slab quarries at *Valentia* have been described (*ante* p. 342), but besides these there are many local openings into the slate veins, the stones from which are principally used merely for walling; but some of them are wrought into slate, the stone usually being carried from the quarry to the building in the rough state, and there split into slates by the slaters. On this account all through this district there are many places known as "slate quarries," although a slate was never split in them.]

KILDARE.

In the east of this county, where slate rocks occur, they are commonly used for general walling purposes. They are often of

a gritty character. The walling of the Round Tower at Kilcullen is of the slate rock of the locality, the doorway being of granite. In the upper portion of the Round Tower at Kildare slate rock is used indiscriminately with granite, sandstone, and limestone.

KILKENNY.

Extending across the south portion of this county, from Tipperary into Wexford, there is an area of slate rocks. They principally belong to the *Ordovicians*, only a few occurring in the *Lower Carboniferous*. They are good for walling, and are found in many of the ancient buildings, sandstone (sometimes Caen (?)), having been used in the dressings.

In the north of the county the *Coal-measure* shales yield bad building stones. Some of the shales, raised when the coals were being worked, after they had disintegrated or "melted," were found to be an excellent top-dressing for the land, while others were injurious, burning off the herbage. The bad qualities of the latter seem to have died out in time by exposure, as all the stacks of them that existed a quarter of a century ago have been apparently used up. Good roofing slate can be procured, as mentioned, *ante* p. 343.

KING'S COUNTY.

Slate rocks occur only on the south-east, in the small portion of Slievebloom that extends into this county. They are very little used.

LEITRIM.

Schists, slates, and shales occur in the *metamorphic rocks* and the *Coal-measures*, and some of them are locally employed for walling purposes.

LIMERICK.

In the exposures of *Ordovicians*, in their marginal tracts of *Lower Carboniferous* rocks, and also in the *Coal-measures*, slates and shales occur. Here and there some of these are extensively quarried for general building purposes. Near Glin there is a hard, compact *Coal-measure* shale, very suitable for walling.

LONDONDERRY.

Here, as in the neighbouring counties of Donegal and Tyrone, there is a large tract of more or less altered rock, probably equivalents of the *Ordovician*, and perhaps partly of the *Llandovery* strata. In the less altered rocks the slates and schists range from fine and argillaceous to coarse and arenaceous. Some of the latter, which perhaps are more properly sandstones than schists, and have already been mentioned in the paper on sandstones (*vide*, page 279), are largely used for all common walling purposes in Derry and its neighbourhood. The principal quarry is at *Prehen*, where there is a bluish stone, of a slaty structure; but there are several others, the stones varying slightly in colour and texture. Elsewhere, within the district, the schists and slates are the materials generally used for building purposes; but they are nearly always unfit for dressed work or quoins. Some contain iron, which soon oxidises and gives a dirty, burnt appearance to the walls. Some of the fine varieties split into coarse slates, and are occasionally used for roofing purposes.

LONGFORD.

In the north of this county, in the *Ordovicians*, at the southwestern end of the already-mentioned large tract of these rocks in Cavan, &c., as also in a few small outlying patches, and in the associated *Lower Carboniferous*, slate rocks occur. These are locally used for walling, similarly as in the adjoining county of Cavan.

LOUTH.

Here, as in the adjoining counties—Cavan, Monaghan, and Armagh—there is a considerable area of *Ordovicians*; and in them, as elsewhere, there are a number of varieties of slate rock, more or less suitable for ordinary building purposes. In this area slate was used by the old people, as exemplified in the ruins of the ecclesiastical buildings at Monasterboice, which are constructed almost wholly of them. “The old round tower is a good example of the working of this material, the stones being shaped to the curvature of the circular surface.” (*Wilkinson*.)

The stones used in Monasterboice seem to have been procured

in the immediate vicinity. Near the old gateway at Mellifont, and in other places in that part of the county, there is a dark-grey compact slate, with a tendency to split into laminæ. "This, if properly worked, would be a very useful and good material for many purposes, as it admits of division to any moderate thickness required." (*Wilkinson.*)

MAYO.

As in the adjoining county of Galway, the slate rocks in the *Arenigs*, *Ordovicians*, and *Silurians* of Mayo are often more or less metamorphosed into schists. Slate rocks also occur in the *Lower Carboniferous* and the *Coal-measures*.

In the areas in which they are found the older slates and schists are very generally used for ordinary building purposes, sandstone and limestone being used for the out work. They are very varied in character. "West of Swineford the slate rocks have vertical cleavage and joints, and subdivide, when much exposed, into large, flat-bedded masses, standing on edge. A peculiar mass of rock of this kind appears above the surface, a few miles north-west of Swineford, and, from the large square-shaped and moderately thick beds of the rock, presents such inviting and ready-prepared materials for walls of great magnitude as almost to cause a wish that the available powers of the present day should make some bold use of them." (*Wilkinson.*) According to Symes, the splitting into these cyclopean slabs have been produced by water freezing in the cleavage divisions. Slates that have been used for roofing purposes occur in places previously mentioned.

MEATH.

The slate rocks occur principally in the northern part of this county, and have been extensively used in *Kells*, both in ancient and modern times, the stone generally used being more or less gritty. St. Columbkille's house, at *Kells*, as also the round castle there, are built of a hard, durable rock, that does not admit of much working. A similar stone is found in the old church and round tower at that place, but mixed with limestone, the out-work being of sandstone. In the quarry to the east of *Kells* the stone is exceedingly hard and brittle, rising in angular and wedge-shaped

masses, while in the quarry to the west it is much kinder, laminated, and compact.

Elsewhere in the slate areas it is very generally used for walling.

MONAGHAN.

A considerable area of this county is occupied by part of the great *Ordovician* tract, so frequently mentioned already, the slate rocks of which have been described under Cavan. In the towns of Monaghan and Clones these rocks are used, along with limestone, for general building purposes, but elsewhere by themselves.

In the north part of the county, in the *Slievebeagh Series* (Carboniferous, *vide* SANDS and SANDSTONES, page 291) there are shales locally used for rough walling.

QUEEN'S COUNTY.

In this area, as in other parts of the central plains of Ireland, there are slate rocks in the *Ordovicians* and in the *Lower Carboniferous* strata, while to the south-east there are *Coal-measure* shales.

The general characters of the last are given in the description of the Kilkenny rocks. The slates and shales of earlier formations seem to be only sparingly utilised, the associated grits and sandstones being preferred.

ROSCOMMON.

In this county the slate rocks seem to be of little account, except for farm purposes.

SLIGO.

The slate rocks, except in the *Coal-measures*, have been more or less metamorphosed into schist and gneiss. The schists are used locally for walling and such like. The *Coal-measure* slates do not

appear to be much used, as they are nearly always associated with thin-bedded, nicely-jointed sandstones.

TIPPERARY.

Slate rocks occur in the *Ordovician* and in the marginal *Lower Carboniferous* strata of this county, and also in the *Coal-measures* as shales.

The slate rocks are not very generally used for building, on account of the proximity of the limestone or sandstone, which are often more suitable for that purpose; but some of them can be wrought into good slates (*ante*, p. 346).

TYBONE.

In the northern part of the county there are slate rocks more or less metamorphosed into schists, in the strata which are probably the equivalents of the *Ordovician*, *Arenig*, and possibly *Cambrian*. Near Pomeroy they also occur in a small tract of *Llandovery* (?) and in *Silurian*, that extend from Pomeroy westward into the county Fermanagh.

In the metamorphic area, especially in the neighbourhood of Strabane and Castlederg, the slates and schists are largely used for common building purposes. In the *Lower Carboniferous*, the *Calp*, and the *Coal-measures* there are shales used for local purposes.

WATERFORD.

The slate rocks of the *Ordovician*, *Devonian*, and *Carboniferous* districts of this county are used for walling purposes, the dressings being limestone, sandstone, or granite. Near Waterford very gritty slates, already described among the sandstones (*vide*, page 309), are quarried at Grange Hill, south of the river; while north of the river more argillaceous rocks are also quarried for walling and general building purposes. The stones in the north quarry can be

raised in large, flat-bedded rough blocks, suitable for foundations or heavy work.

There are good veins of roofing slates (*see* p. 350).

WESTMEATH.

Slaty rocks are nearly quite absent; they occur only as subordinate beds in the *Carboniferous* strata.

WEXFORD.

Slaty rocks occur very generally throughout this county. In some places, however, they have been metamorphosed into schists, or even gneiss (?) They vary greatly, from roofing slates to gritty slates—the latter passing into grits and quartzite. They are very extensively used for walling and rubble in all the towns and in the ancient buildings, as in the castles and churches of Ferns, Enniscorthy, &c.

In places there are veins of roofing slates, mentioned at p. 350.

WICKLOW.

This county, like Wexford, is largely occupied by slaty or allied rocks, which have been used extensively for common building purposes in Bray, Newtownmountkennedy, Wicklow, Rathdrum, Arklow, Tinahely, Carnew, Shillelagh, &c. Many of them are more or less metamorphosed; but in general all give good flat-bedded stones, often of large sizes, capable of producing good work. They very seldom dress well on the edges. Many, however, might be sawn; but this is not practised, as granite is generally used for dressings and quoins.

In Saint Kevin's Kitchen, *Glendalough*, there is a high-pitched roof, built in horizontal courses, partly supported by a cylindrical vault made with voussoirs, both of micalyte. Anciently, and up to the middle of this century, the majority of the monuments at the Seven Churches were slabs of micalyte, some of the ancient ones being elaborately carved. But nearly all the more modern ones in

the large graveyard were some years ago replaced by limestone ones, while subsequently many of the latter have been in their turn replaced by sandstone or Bath stone, thus depriving the place of its ancient look and character, and giving it the appearance of a modern cemetery.

V.—SLATES AND CLAYS OF IRELAND (BRICKS, ETC.). BY
G. H. KINAHAN, M.R.I.A. WITH INTRODUCTION AND
BUILDING NOTES BY R. CLARK.

[Read January 18, 1888.]

PART II.—THE CLAYS OF IRELAND (BRICKS, ETC.).

THE Irish Clays to which attention will be directed are : *Alumite*, or Alum Clay : *Diatomite*, or Diatomaceous Clay ; *Fire-clay*, *Porcelain*, or China-clay ; *Fuller's Earth*, *Pipe*, *Potter's*, and *Brick-clays*.

The *Alumite* occurs as a subordinate in the Tertiary *Iron-measures*, Co. Antrim ; it is used in the manufacture of alum, &c. (p. 55).

*Diatomite*¹, when of good quality, is nearly pure silica, being made up solely of diatoms ; it is now used in the manufacture of dynamite to mix with the nitro-glycerine. It usually occurs as an accumulation under, or associated with, peat, in bowl- or saucer-shaped hollows. Lately it has been discovered in a number of places in North Scotland, but as yet, in Ireland, it has only been found in the valley of the Bann, Cos. Londonderry and Antrim (page 369).

Fire-clay is recorded in the different coal-fields and tracts of coal-measures. In the Co. Tyrone (*Coal Island* and *Annaghone*) it occurs in quantity, and of excellent quality (page 386). In the Leinster coal-fields, also, as pointed out years ago by Griffith, it is plentiful and good ; but for some unknown reasons it never appears to have been utilized. In the Connaught coal-fields, where the quantity is less and the quality inferior, it was for a short time manufactured into bricks and other fire-ware ; but there are no records

¹ NOTE ADDED IN THE PRESS.—More recently, on account of the quantity of silica it contains, it has been proposed to be used in the manufacture of fire-resisting cases for metal pipes, &c., specimens of which are exhibited in Glasgow at the present time (June, 1888).

of the fire-clay having been used elsewhere, except very locally for the lining of hearths.

A steatitic clay, the "back," or weathered portion of the beds of pure phyllite and intrudes of steatite, is also used for hearths and the lining of forges (p. 58).

An unctuous clay, called *Doab* in Connaught, occurs in places in the granitic and metamorphic areas of Galway, Mayo, Donegal, &c. It is very commonly used for making floors and for mortar; while from some of the purer varieties whitewash can be made.

Porcelain, or China-clay, or Kaolin.—A clay due to the decomposition of very felspathic rocks; it may occur as a surface accumulation, or as the weathered portion of a felspathic dyke or intrude, or it may be artificially made. Baron von Richthofen has proved that Kaolin is manufactured by the Chinese from petrosilex or granulite; its name was derived from "Kaolin," *anglice*, "Low ridge," the name of the hill on which the China-clay was originally manufactured. The name is now applied promiscuously to the artificial and natural clays.

At *Kilranelagh*, near Baltinglass, Co. Wicklow, kaolin of a fine quality has been obtained; at Tullow, Co. Carlow, there is a porcelain clay, but partially impregnated with iron; while a little S. E. of Westport, Co. Mayo, a decomposed petrosilex forms a dyke of kaolin. Lewis mentions "clay fit for porcelain and every other description of earthenware" as having been sent from Mayo to England, but he does not mention the locality where it was procured. The Ballymanus dyke, Co. Wicklow, is a silicious kaolin. In different places there are felspathic rocks suitable for the manufacture of porcelain clay. Near the sea, in the country south-westward of Roundstone, Co. Galway, there are dykes of very pure felsite, suitable for kaolin manufacture, while in the same county, near the city and in other places in the vicinity of Galway Bay, are very pure leptinites and other felspathic rocks. At Belleek, Co. Donegal, kaolin is manufactured from a pink orthoclase; this is kept for the finer ware (*Belleek ware*), while the clay for the delf and common wares is made from imported stone.

In the Co. Wicklow, in the vicinity of the Ovoca mines, and in other places, there are very pure felsites and leptinites. Attention was directed to these years ago by Weaver; but as yet they have

not been utilized. The water power of the Ovoca and of the smaller rivers might easily be applied to the crushing and grinding down of these stones into kaolin.

Fuller's Earth is probably a product of the decomposition of basic igneous rocks; it may occur as a dyke, as in places in North-West Galway, or as beds, or accumulations associated with the drifts. Formerly Fuller's earth was very extensively used for thickening cloth; but this is now done by other means, and the clay trade has consequently died out, it being used only by some of the country folk.

Pipe-clay is more usually found among the drift deposits, but in the Cos. Tyrone and Tipperary beds of it occur in older geological formations. The pipe-clays of these counties were more used formerly than they are at present. The Tipperary clay was at one time exported to England to be manufactured into "cups and saucers, and all the finer kinds of wares."—(G. S. M.). There seems to have been, in former times, a considerable trade in tobacco-pipe making in Dublin, Cork, Athlone, Brosna, near Roscrea; Cahir, in Co. Tipperary, and other places; but now this trade has greatly decreased, except in Dublin, and perhaps Cork.

Potter's Clay and *Brick-clay*.—These are more or less similar; the finer varieties being called Potter's clay, or even Pipe-clay. They occur more or less scattered over the country in patches and beds associated with the surface accumulations, but vary very much both in quality and quantity. They also occur as subordinate beds in some of the series of rocks, such as the Fire-clays in the coal-measures; the marls in the Trias; and the Alumite, Lithomarge, and Bole in the Tertiary Dolerites. These older clays, except the Alumite, have been very little utilized; but lately at Kingscourt, on the confines of Cavan and Louth, an excellent brick has been made from the Trias clays; and as this class of clays is also found in other places in Ulster, a similar trade might be started in other localities. Some of the shales in the Lower coal-measure are easily reduced into clay, excellent for brick-making, yet we only know of one place, viz. Cashel, Co. Tipperary (p. 386), where this has been done. There are also the "spoil banks," or waste heaps, at the different slate quarries; the material in general, if ground down, being eminently suited for brick-making. The removal of such heaps would not only be a source of profit, but

it would be also of great benefit to the quarries to clear away the heaps that are now so much in the way, and cause such additional expense. There would be every facility for such a trade in connexion with the slate workings in the vicinity of the Suir, to the westward of Waterford, as fuel could be brought and the brick sent away in boats.

Many of the Irish facing bricks are panelled, and a few like those of Castle Espie, Co. Down, and Courtown, Co. Wexford, are perforated. Perforated bricks cost less for carriage, but are not as lasting in face-work as the solid brick, damp and frost making their way into the perforations, thus making the bricks liable to moulder away.

The prices of bricks, especially in the country places, change so rapidly, according to the time of year and demand, that it is impossible to give them accurately. Even in Dublin at one time they may be much higher or lower than they were a few months previously; we have tried to give a fair average; our estimate, however, may be, for some places, too low.

ANTRIM.

ALUMITE, or ALUM CLAY.—This occurs as one of the members of the IRON ORE-MEASURES in the Tertiary Dolerites. It has been already mentioned and described in the first Paper of the series on IRISH METAL MINING (pp. 55 and 65).

DIATOMITE, or DIATOMACEOUS CLAY.—The only Irish localities for this clay at present known are those in the Cos. Antrim and Down in the alluvium of the Bann Valley, to the northward of Lough Beg; it being locally known as "Bann Clay."

Bann Clay occurs on the north of Lough Beg, where it is mixed with grey stiff clay for the manufacture of bricks. Between Lough Beg and Portglenone it is from four to five feet deep, and is applied to similar purposes. At Annagherew, north of Portglenone, it is only one foot thick; but further northward, south of Portna, it has increased to two feet. Still further northward it is again found along the narrow flat north of Kilrea, and can be traced as far north as Ballynacree House. At New Row, where there are brick works, it is four feet thick, and lies on five feet of peaty clay—(G. S. M.). This clay is brownish-grey in colour, weathering white. It is nearly pure silica, being made up almost

entirely of the shells of Diatoms. ("Guide to Belfast," &c., by *Belfast Naturalists' Field Club*, p. 73.)

At the present time the sole use it is put to is to mix it with clay to burn into bricks of an excellent quality. It is, however, evidently capable of being more profitably employed. For some time dynamite was manufactured with silicious clay imported from the Continent; but rather recently diatomite, or diatomaceous clay was discovered in Scotland, and since then its presence has been proved in various places, which has led to the introduction of a new and profitable industry. The "Bann Clay" is apparently equal to many of those Scotch clays, and superior to others; it may therefore be suggested that here probably there is a valuable source of profit at present unknown.

BRICK CLAY is found in several places within the county, and manufactured. Bricks are made in the neighbourhood of Antrim, 16s. to 25s. per 1000, $8\frac{1}{2}'' \times 4'' \times 3''$, weight 6 lbs; in many places within four miles of Ballycastle, 15s. to 20s., $8 \times 3\frac{1}{4} \times 2\frac{1}{4}$ and $9\frac{1}{4} \times 4\frac{1}{4} \times 3\frac{1}{4}$, weight 6 lbs.; near Ballymoney, $8\frac{1}{4} \times 3\frac{1}{4} \times 2\frac{1}{4}$, weight 4 lbs.; in the vicinity of Larne, 24s., $9 \times 4 \times 3$, weight $6\frac{1}{2}$ lbs.

Bricks are made in great quantities near Belfast; the best coming from Haypark Works, Ormeau-road, size $9 \times 4\frac{1}{4} \times 3$, 30s. to 35s. per 1000. Demand very brisk; works over twenty-five years old.

The fire-bricks in use in Belfast and other places are from Glasgow, 55s. per 1000.

For the following information in connexion with Belfast, &c., we are indebted to *Mr. William Swanston*.

BELFAST.

(*Cos. Antrim and Down.*)

CLAY PIPES.—One of the so-called "Dane pipes" was found in an ancient cairn on Scrabo Hill, associated with Roman remains, and silver coins with Hiberno-Danish characters of about A.D. 1017. Both the pipes and the coins are supposed to be of much later date than the cairn. "Dane pipes" have also been found elsewhere, as in the excavations for the main sewer, High-street, Belfast, in Carrickfergus, in Dromore, in Lisburn, and in Larne. They are

found near the surface, or in connexion with old buildings. The place or places where they were made are unknown. At present in Belfast there are about five manufactories on a small scale, the clay being imported from Devonshire.

POTTERY.—In Dr. Molyneux's "Tour in the North of Ireland," 1708, we find, "Here we saw a very good manufacture of earthenware, which was nearest to delft of any made in Ireland, and really is not much short of it. It is very clear and pretty, and universally used in the North, and I think not so much owing to any peculiar happiness in the clay, but rather to the manner of testing and mixing it up." On the map of Belfast, 1791, there are two distinct factories marked "Pottery and China Manufactory." According to George Benn, "History of Belfast" (1877, p. 355), these manufactories were relinquished in 1799. It is not known where the clay was procured.

Old bricks are found in Carrickfergus and Dundrum Castles, but they appear to be much more recent than the original structures. They are much smaller than those now in use, and tradition says they were imported from Holland in the reign of William III. At the present time in the neighbourhood of Belfast, and elsewhere in the Cos. Antrim and Down, bricks, flooring-tiles, ridge-tiles, drain-tiles, and such like, also flower-pots, are manufactured, generally from the washed "Till," but also from the clays of the Keuper marls. In all cases the presence of clay in a suitable position is the main desideratum in establishing works. It has been the custom in the neighbourhood of Belfast to take ground likely to come in soon as building sites, and make bricks on the spot.

ARMAGH.

POTTER'S CLAY is mentioned by Lewis (1837) as found in this county; but no locality is given.

PIPE-CLAY of a good quality, and in a stratum 41 feet thick, is said to have been got at a depth of 30 feet when sinking a well a little west of Ardress House.—(G. S. M.)

Very good red BRICKS are made in various places in the vicinity of *Armagh*, 20s. to 25s. per 1000, $9\frac{1}{2} \times 4\frac{1}{2} \times 3$; while those made in

the vicinity of Lurgan are inferior, 25s. per 1000, $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$, weight, 7 to 8 lbs.

Along the river Callan, eastward of Moy, a greyish-whitish brick-clay occurs.

CARLOW.

Most of the so-called Carlow bricks are made in the Queen's Co., in the county west of the Barrow. (See QUEEN'S CO., p. 384.)

Kildarin, near Newtownbarry, "worked into various articles of pottery, which find a market not only in the neighbourhood, but in Kilkenny and Waterford."—(G. S. M.)

FIRE-CLAY.—(See KILKENNY, p. 379.)

CAVAN.

POTTER'S CLAY occurs in nearly every townland in the N. W. of the county; and some of it is of the best and purest kind (*L. D.*). Sir Charles Coote, in the Statistical Survey, 1801, directs attention to the potter's and brick-clays.

Patches of BRICK-CLAY producing bricks of the most durable quality are also common. Bricks are made in different places within three miles of *Bailieborough*, 25s. to 30s. per 1000, $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$, weight $6\frac{1}{2}$ lbs., and very inferior brick near Cavan.

FIRE-CLAY.—In the *Lough Allen*, or *Connaught Coal Field*, the recorded fire-clay beds are thin, and in general of inferior quality. One mile N. W. of the *Arigna* Iron Works there is a bed three feet thick, but thinning out northward and southward; this was formerly worked by the *Arigna* Coal Company, and very fair bricks made out of the clay.

CLARE.

POTTER'S CLAY found in places in the west of the county.

BRICKS of a red colour are made at *Clare Castle*, *Manus*, *Ballycorick*, and *Rosshanaher*, from the clay of the *River Fergus Valley*, 20s. to 30s. per 1000, $9\frac{1}{2} \times 4\frac{1}{2} \times 3$, weight $6\frac{1}{2}$ lbs.

FIRE-CLAY.—In the *West Munster Coal Field* (*Cos. Clare, Limerick, Kerry, and Cork*) various beds are recorded, being from six inches to two or three feet thick, under most of the coals. In

places, especially in Clare, Kerry, and Limerick, these clays ought to be capable of being worked profitably, the peat of the country being used to burn the bricks, &c. Moreover, in some localities the small coals on the clays, which are now valueless, might be worked as a by-product.

CORK.

Tobacco-pipes have been for a long time, and are still, made in *Cork city*; formerly some of the clay was brought from the Co. Clare, but now it is all imported from England.

There was, until a few years ago, bricks and coarse pottery made in Cork, the clay being brought from *Youghal*.

Coarse bricks were made at *Derrylinn* from a local clay, and finer ones at *Balvelly* (Great Island), also from a local clay. They were somewhat like the *Bridgewater* bricks, but softer, and after a time threw out a "white salt." At *Ballinphealing*, near *Ballinhassig*, bricks are made. On the *Douglas channel*, about three miles from Cork, the slob of the estuary is wrought into bricks, which are used in large quantities for stud work. The clay, if washed, will not burn; but when dried and unwashed it burns into a durable brick; cost, 11s. to 14s. per 1000; size, $8\frac{1}{2} \times 4 \times 2\frac{1}{2}$; weight, 4 lbs. Similar clay, got at *Ballinalee*, three miles from *Kinsale*, is also used for bricks, 12s. to 14s. per 1000. In the vicinity of *Mallow* inferior bricks are made from a local clay, 20s. to 35s. per 1000, $9 \times 4 \times 2\frac{1}{2}$. Near *Skibbereen* a few bricks are made.

"In the neighbourhood of *Youghal* there is, near the surface, a ten-foot-thick bed of very good reddish shaly clay, very smooth and close, but having a slight mixture of sand. This clay is manufactured into bricks and coarse pottery, tiles, draining-pipes, flower-pots, &c.: lately some ornamental flower-pots, of a light-red colour, well shaped and cheap, were made, the material, however, is coarse. The bricks, $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$ ", are very superior, and formerly were extensively sent to Cork, Waterford, and Dublin. About 2,000,000 of the *Youghal* bricks were used in roofing the tunnel of the Great Southern and Western Railway as you go into Cork. Best bricks of a fine clear brownish-red, 25s. per 1000, a softer kind of a dull light-red colour, 20s. per 1000." (*J. Budd.*)

The *Youghal* bricks were used in the building of the *Tipperary barracks*. They are not now in the *Dublin market*, it is said on

account of prohibitory freight. Some of the Dublin builders who have used them say that "they are the best in Ireland."

FIRE-CLAY (*See* Co. Clare, *ante*, p. 371).

DONEGAL.

POTTER'S CLAY occurs on Arran Islands, in the *Rosses*, in *Tory Island*, and at Drumarda on Lough Swilly; it has been used a little in the manufacture of coarse pottery. PIPE-CLAY is found frequently, but little used. *Dr. Parland* in his Statistical Survey, 1801, called attention to the pipe- and brick-clays in Drumarda. At that time the natives of Tory "made clay-pots, in which they boiled potatoes or anything else."

BRICKS are made at *Moy*, two miles from Ballyshannon, but they are unshapely, 8s. to 12s. per 1000; a few are made near *Donegal*. They are also made at *Milk Island*, near Letterkenny, and at *Ramelton*, from the clay of the "isles" or flats margining Lough Swilly; at Drumskillin, in Inishowen, $9 \times 4\frac{1}{2} \times 3$, weight $5\frac{1}{2}$ lbs.; Strawbridge, very inferior quality; Burnfoot railway station, 20s. per 1000, also draining and other tiles; and Ardnaree, five miles from Millfort, 18s. per 1000, $9\frac{1}{2} \times 4\frac{1}{2} \times 3\frac{3}{4}$, weight 8 lbs.

In the blue brick clay margining Lough Swilly, about a mile eastward of Ramelton, Mr. Mahony found a fossil deer's horn.

DOWN.

In *Ballymacarret*, the eastern suburbs of Belfast, there were china and delft works for many years; whence the clay, &c., was procured we were unable to learn. (*See* BELFAST, *ante*, p. 370.)

Very good BRICK-CLAY occurs near *Banbridge*, from which red but not well-made bricks are manufactured; but a first-rate brick could be made from the clay, 25s. to 28s. per 1000, $9 \times 4 \times 2\frac{1}{2}$; inferior bricks are made at *Downpatrick*; red at *Kilkeel*, 20s. to 25s. per 1000, $8\frac{1}{2} \times 4 \times 3$, weight $6\frac{1}{2}$ lbs.; small red bricks at *Rostrevor*; in different places in the neighbourhood of Newry, 20s. to 24s. per 1000, $8\frac{1}{2} \times 4\frac{1}{2} \times 2\frac{3}{4}$, weight $6\frac{1}{2}$ to 7 lbs, and very inferior at Newtownards. There is good brick-clay near Portadown, and extensively wrought.

Hard red bricks are made from the clay of the boulder drift west of Waringstown. This clay also occurs in cuttings along the

Lisburn and Banbridge Railway. Very superior bricks are made near Maypole, north of Dromore.—(G. S. M.) Brick-fields were started in plastic clay near Ballyhorney, and at Ardtole, near Ardglass.

Castle Espie.—In this neighbourhood there is an extensive trade in bricks, principally for the Belfast market, and in tiles. *Terracotta* also has been attempted there. The bricks are of a red colour, moulded, and perforated, and equal, if not superior, to the best Bridgewater bricks. They are made from the washed boulder clay.—(G. S. M.)

DUBLIN.

PIPES.—Tobacco-pipes were made in the neighbourhood of Dublin at a very early date. Quantities of those known as “Dane-pipes” were found in Baggotrath, in the excavations for Waterloo-road. The early manufacturers possibly used Irish clay; but in later years the material was probably imported. Francis-street has long been the great home of the Tobacco-pipe makers; the “Crown L,” made half a century ago by Loughlin, were world-famed. At present there are about nine tobacco-pipe makers in Dublin.

Dr. Frazer, M.R.I.A., one of the best authorities on the antiquities of Dublin, thinks it likely that the “Dane-pipes” were of English manufacture (*Introduction, ante*, p. 367); but in Baggotrath there were in different places heaps of the *debris* of pipes, similar to those now to be seen near a pipe-kiln, which lead us to believe they had been made on the spot.

FULLER’S EARTH occurs in places, but it is not now as valuable as formerly. In different places associated with the gravels above the boulder-clay there are POTTER’S and BRICK-CLAYS; but, unfortunately, in many places there is a heavy off-baring of gravel that makes the clay expensive to get.

Tradition has it that the houses in Merrion-square, and neighbouring houses, were made from clay procured near Merrion, also clay raised in the Square. Lately, while building the new streets between Cork-street and the South Circular-road, the bricks were burnt on the ground. When Waterloo-road was being made from Upper Baggot-street to Donnybrook, a bed of potter’s or brick-clay was found. There are regular brick-yards and potteries

in various places about Dublin, making use of clay raised on the spot. Regular brick-yards exist at Balbriggan and Ellistown, four miles westward of Lusk.

Kill-o'-the-Grange.—The pottery and brick-yard at this place is of long standing; formerly it had an extensive trade in coarse pottery, flooring and roofing-tiles, draining-tiles, chimney-pots, flower-pots, and bricks. Some years ago the bricks, through careless work, got for a time into disrepute, but of late years they have been good, though not equal to those of Kingscourt, Co. Cavan; size $9 \times 4\frac{1}{2} \times 3$; delivered in Dublin at 44s. per 1000; cartage about 10s. per 1000. Leinster Hall, on the site of the Theatre Royal, built of them.

Foxrock, a little more than a mile S.W. of Kill-o'-the-Grange. —Bricks were made here a few years ago.

Clondalkin.—The bricks made here are the "old Co. Dublin stock-brick," and are $9 \times 4\frac{1}{2} \times 3$. They were extensively used formerly; all the old buildings in Dublin and the best old streets were built of them; price, about 45s. per 1000. The clay was laid out and turned during the winter, and hand-picked, to remove all the lime-gravel. The bricks were principally made at the Fox and Geese, Ashfield, and near Red Cow. They were formerly made at Cloverhill, ninth Lock, Grand Canal, and are still made by Flood and a few others, but from want of proper care they have much deteriorated in quality; colour brownish-yellow; about 350 go to the ton.

The red bricks to be seen in some of the old mansions, in Rutland-square for instance, were made at Clondalkin; they did not, however, stand the weather, the faces yielding to atmospheric influences. Hence has arisen the custom of "Wigging," or renovating the faces with Venetian red. This custom to a great extent is confined to Dublin, and is not to be approved of, as the brick wall is re-pointed with plaster of Paris, flat pointing being always better than French pointing.

Ratio.—1000 Athy stocks equal $2\frac{1}{2}$ cubic yards. 1000 Dublin stocks equal $3\frac{1}{2}$ cubic yards, both in Flemish (*Irish*) and English bond. An Irish perch of brickwork is 21 ft. \times 12 in. \times 9 in.

[The "Flemish bond" which is that generally used in Ireland, except perhaps in Belfast, consists of headers and stretchers alternating, while the "English bond" is a course of headers, then three courses of stretchers, then a course of headers, and so on.

The Co. of Dublin stocks that were used when building the Theatre Royal, Poolbeg-street, were so good, that after it was burned, and when the Leinster Hall was being built on its site, the old bricks were so firm and intact that most of them were used in the new building. Co. Dublin stocks, at 45s., dropped out of the market through the importation of the Cardigan brick at 39s. The latter is an inferior article, as the Co. Dublin brick is probably worth 5s. per 1000 more than the Cardigan red stock. The supply is now limited in consequence of their being undersold by the Kingscourt and English bricks. The Dublin stock is neither panelled nor perforated.]

Mount Argus, Harold's Cross.—The bricks made here are red and grey in colour, $9 \times 4\frac{1}{4} \times 2\frac{3}{4}$, perforated, price 38s. per 1000. They are good and well burnt, but contain lime. The works have been open only a few years, yet they have great custom. These bricks have been used in the buildings of the Royal University, and in many others for front work.

Portmarnock. Brick and Terra-cotta Work. Red brick, good class, $9 \times 4\frac{1}{4} \times 2\frac{3}{4}$, delivered in Dublin, common 43s. 6d., facing, 47s. 6d., chamfered, bullnoses Scotia, 50s., others moulded 55s. per 1000; used in new houses in Sallymount-avenue; Leeson-park; Rathmines National School, &c.; new wing of Incurable Hospital, Donnybrook, &c., &c. These bricks, especially those in the Rathmines School, look extremely well.

Pelletstown, one mile S. W. of Finglas. A good clay, capable of making good bricks. Has not been worked for some time.

RECENT BRICK STRUCTURES.—Besides those already mentioned there are M'Gough Home, Cullenswood, *Courtown, Co. Wexford*; facing Bridgewater. Guinness's House, &c., Earlsfort-terrace, *Bridgewater*.—In all the red facing of the new houses in Pembroke and Rathmines Townships, and the North Circular-road, built prior to about the year 1885, *Bridgewater* nearly solely used. National School and Teachers' Residence, Rathmines, *Portmarnock*.—New Station, Westland-row, various bricks.

[The brick trade, like all other trades, suffered during the general depression which affected the country in 1852, and subsequent years; and before it could recover, foreign bricks had in a great measure taken the place of the Irish, principally Cardigan and Bridgewater; the latter commenced to be run on about 25 years ago. The Kingscourt brick is a first-class article, equal to the Bridgewater, and of a better colour; it has rapidly made its way.

Price of a cubic yard of brick-work—bricks 13s. (at 40s. per 1000), labour 9s., mortar 2s., scaffolding 1s. = 25s.; 1000 build $3\frac{1}{2}$ cubic yards; 1 cubic yard = 27 cubic feet; 1 Irish perch = $15\frac{1}{2}$ cubic feet, or 21 feet long by 12 inches high and 9 inches thick. Ratio, Athy stock, 1000 = $2\frac{1}{2}$ cubic yards; Dublin stock, 1000 $3\frac{1}{2}$ cubic yards, in both English and Flemish (Irish) bond.

Fire-clay Ware.—Flue linings are extensively imported, principally from Chester and Glasgow, chief sizes 9 and 12 inches high, prices 3*d.* and 4*d.*, about 200 to the ton. Chimney-pots, 1, 2, and 3 feet high, principally from Glasgow, plain, moulded, and ornamented, from 1*s.* 5*d.* to 2*s.* 9*d.* each; freight, according to season, from 4*s.* 6*d.* to 5*s.* 6*d.*, Chester; while the Scotch freight would be about 10*s.* Scotch drain-pipes 3 feet long; Chester 2 feet 4", 6", 9", and 12" in diameter; prices, 4½*d.*, 6½*d.*, 8½*d.*, and 11*d.* in Dublin. Traps, dill's closets, &c., are also imported from Scotland and Chester.]

FERMANAGH.

BRICKS are made at *Newtownbutler*, for use at Clones, six miles, distance; *River Arney*, ten miles from Enniskillen, to supply that town; bricks, however, are very generally made all through the flats about Loughs Erne, 8*s.* to 12*s.* per 1000, $9 \times 4\frac{1}{4} \times 2\frac{3}{4}$, weight 6 lbs.; alluvial flats near Lisnaskea, 12*s.* to 15*s.*, $8\frac{3}{4} \times 4 \times 2\frac{3}{4}$, weight 6 lbs.

In the flats east of Upper Lough Erne there are considerable deposits of brick-clay extensively burned by the inhabitants, principally for local use. At Arney Bridge some kilns were worked by the late Lord Enniskillen for many years. In 1880 were turned out, between 1st April and 1st November, 402,795 pipes of different sizes, 100,000 bricks, 29,200 flooring- and roofing-tiles, 120 yards of ridge-tile, 1023 doz. flower-pots, 100 doz. saucers, and a few other articles, such as chimney-pots, &c.—(G. S. M.)

Belleek.—For some years china, including a peculiar glazed kind, *Belleek ware*, delft, &c., have been manufactured in this town. The best ware is made of kaolin, manufactured from a felspar vein in the neighbourhood, while impurer felspar for the common ware is imported. (See *Introduction*, p. 366.)

FIRE-CLAY.—(See CO. CAVAN, *ante*, p. 371).

GALWAY.

Tobacco-pipes and coarse pottery were formerly made at *Galway*, *Creggs*, and *Dunsandle*, from clay obtained in the respective vicinities. An excellent clay was discovered some ten years ago in the neighbourhood of Menloe Castle.

BRICK at *Annaghdown*, east of Lough Corrib, yellow, 16*s.* to 21*s.* per 1000, $8\frac{1}{2} \times 4 \times 2\frac{3}{4}$, weight 5½ lbs.

In the flats near Clare-Galway and Athenry coarse bricks are made. In the early English Castle of Clare-Galway bricks were

used. They are not rectangular ; but were moulded slightly wedge-shaped, so as to fit in as voussoirs in a nearly flat arch.

In places near Portumna, Eyrecourt, Banagher, &c., in the flats of the Shannon, bricks and draining-tiles have been made, but not of the best class.

KERRY.

Very good BRICKS made at *Listowel*, for about 20s. per 1000, size $9 \times 4 \times 3$, weight 7 lbs. ; fair at Tralee for about 23s. per 1000, $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$, weight 7 lbs. On the Coal-measures in the east of the county there are, in places, brick and other clays.

FIRE-CLAY.—(See *Co. Clare, ante*, p. 371.)

KILDARE.

The FULLER'S EARTH at the Hill of Allen was formerly very valuable, but is not now worked.

At Waterstown, two and a-half miles from Naas, a poor brick ; but the bricks used to build Lord Stafford's ("Black Tom") castle at Figginstown, Co. Kildare, were of excellent quality.

The Athy stock-bricks are made in the neighbouring country (*Kildare and Queen's Co.*), and are sent in great quantities by the Grand Canal to Dublin, &c. Prices in Dublin from 30s. to 32s. per 1000, 1000 making about $2\frac{1}{2}$ tons. They are neither pannelled nor perforated. They have been largely used in the suburbs of Dublin ; particularly Rathmines and Rathgar. Guinness's new malthouse and hop store are built of them.

Facing-bricks, $9 \times 4\frac{1}{2} \times 3$, were formerly made and brought by Messrs. Webster and Co. to Baggot-street Bridge for the Dublin market. They were a first-class brick ; and the bricklayers state that they find them in the old buildings in splendid condition. They were used in the old Theatre Royal.

The grey-stock, $8\frac{1}{2} \times 3\frac{1}{2} \times 2\frac{1}{2}$, is well burned, and suitable for factories and such buildings. Their tenacity exceeds that of any imported bricks. They are very suitable for chimneys ; also for arches and walls where machinery is used. They bond more perfectly than most other bricks, and are therefore very suitable for being set in blocks built with templates. The engineer of Guinness's Brewery has found that after fifteen years the concrete arches

under the engine-room have no break in them, this being due to the elasticity of the supporting walls of Athy bricks.

These bricks are well burned, and free from lime; but there is a slight difference as to quality according to the brick-yards in which they are made.

KILKENNY.

Good POTTER'S CLAY at *Castlecomer*; also in the neighbourhood. Prior to 1837, a pottery was commenced there, but failed for want of capital (*L. D.*). Some years later it was again started, but failed; now only a few kilns of bricks are burned.

PIPE-CLAY occurs, and has been worked both in the north and south of this county.

BRICKS are made at Glenmore, three miles from New Ross, with clay obtained below high-water mark, in the estuary of the Barrow. The salt in this clay causes the bricks to become damp in wet weather, and to yield with frost if used in outside work; 12s. to 15s. per 1000, $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$, weight 7 lbs. *Ballywater*, two miles from Callan, inferior, 25s. per 1000, size $9 \times 4 \times 3$, weight 7 lbs. *Kilkenny*, in different places in the vicinity, 25s. to 40s. per 1000, $9\frac{1}{2} \times 4\frac{1}{2} \times 3$, weight $6\frac{1}{2}$ lbs. *Castlecomer*, also tiles, drainage-pipes, and coarse pottery.

FIRE-CLAY.—In the Leinster, or Castlecomer Coal Field (*portions of Kilkenny, Queen's Co., and Carlow*), thick beds occur under most of the coals. Sir R. Griffith, in his Report (1820), spoke very highly of them, yet they seem never to have been utilized. The best bed is under the "Old Colliery," or "Three-foot Coal"; but this is now unattainable, as the expense of draining the old workings and removing the fallen roof would leave a profit out of the question. Those beds that might perhaps be more easily utilized are the four-feet-thick bed under Ward's seam (*Rushes*), and the fire-clays in Towlerton and Woodland, all at the eastern brow of the table-land, as these could be worked by driving in levels; besides, the associated thin seams of coal might be worked as a by-product. There are also in a few places in the strata below the coals (*Middle and Lower Coal-measures*) independent beds of clay that might be worked; and perhaps also the clay under No. 1, or *Gale Hill Coal*. But in all the places where the coal has been extracted, the old workings would have to be unwatered at

great expense before the clay could be obtained, if we except the margin or outcrop of the beds, which in places might be wrought by surface openings.

KING'S COUNTY.

PIPE-CLAY, near Blackball, north of Brosna. Formerly tobacco-pipes were extensively made in Brosna; but the village was destroyed over a quarter of a century ago, and the pipe-makers migrated. The Blackball clay was also used by the late Lord Rosse for lining his furnaces.

Very fair BRICKS are made at several places within three miles of *Birr*, or *Parsonstown*, 15s. to 25s. per 1000, $9 \times 4 \times 2\frac{1}{2}$, weight 7 lbs. Bricks of good quality were made at *Rahan*, *Ballywilliam*, &c., within two and a-half miles of *Tullamore*, and sent by the Grand Canal to Dublin, *Edenderry*, and other places, 15s. to 20s. per 1000, $8\frac{1}{2} \times 3\frac{3}{4} \times 3$, weight $5\frac{3}{4}$ lbs. The bricks now made are of inferior quality, and are not in demand in Dublin. They absorb damp, and can only be used in buildings that are to be plastered or dashed. They have bad bearing qualities, the material being poor and not well burned, 18s. per 1000.

LEITRIM.

At the western base of *Benbo* there is a bluish-white FULLER'S EARTH. At *Dromahaire* there was, at one time, an extensive pottery. There is POTTER'S CLAY at the town of *Leitrim*, four miles N. N. E. of *Carrick-on-Shannon*.

At *Leitrim* there are red BRICKS of three qualities, 15s., 20s., and 25s. per 1000. A good grey brick at *Killucan*, one mile from *Carrick-on-Shannon*, and at *Dromahaire*, nine miles from *Manorhamilton*, which it supplied thence, 18s. to 22s. per 1000. *Mohil*, red, of good quality, 20s. to 25s.

FIRE-CLAY.—(See Co. CAVAN, *ante*, p. 371.)

LIMERICK.

Inferior PIPE-CLAY at *Rathmore*, in *Manasteranenagh* parish.

In the flats of the *Shannon*, about three miles from *Limerick*, BRICKS and TILES are made with clay of a bad quality, 17s. to

23s. per 1000, $8\frac{3}{4} \times 4\frac{1}{2} \times 3$, weight 7 lbs. Near *Newcastle West* the bricks are inferior; although a very good clay occurs in the neighbouring *Coal-measure* hills. *Ballyseed*, near Askeaton, a poor brick, 15s., $9\frac{1}{4} \times 4\frac{1}{4} \times 2\frac{3}{4}$, weight 6 lbs. North-west of Ardagh the late Colonel Dickson erected brick and tile works on a bed of clay.—(G. S. M.)

LONDONDERRY.

POTTER'S and BRICK-CLAY along the Moyola river at *Castledawson*, from which coarse pottery and bricks are made. In the parishes of *Aghadowey* and *Agivey*, south of Coleraine, "a coarse kind of earthenware, bricks, and water-pipes." (*L. D.*)

Good BRICKS within a mile and a-half of *Coleraine*, 12s. per 1000, $8 \times 4 \times 2\frac{1}{2}$. *Muff*, N. E. of Derry, very good bricks, 15s. and 20s., $8\frac{1}{2} \times 4\frac{1}{2} \times 2\frac{3}{4}$. *Ballyronan*, three and a-half miles from Magherafelt, bad bricks. Good in several places in the vicinity of Limavady, 7s. to 9s. per 1000.

"A few miles above Coleraine, on both sides of the Bann, is a reddish or brownish brick-clay in many places, not much used at present; but it is used near Glasgort, and also about a mile west of Coleraine, south of 'Irish Houses.' South of the Agency bridge, the diatomaceous, or 'Bann Clay' (*Diatomite*), is extensively used for brick-making." (*F. W. Egan*.)

West of the Bann, and east of Ballynacree House, there is brick-clay. Near Balnamore House a red laminated clay was formerly manufactured into tiles; while near Glasgort, S. W. of Agivey, similar clay of reddish and bluish-grey colours is now made into bricks, tiles, flower-pots, &c.—(G. S. M.)

Below the peat at Littlebridge, near Castledawson, there is a stiff brown clay, used for brick-making, while "Bann clay" is found below the peat to the west of Church Island, as also further north.—(G. S. M.)

LONGFORD.

POTTER'S CLAY in abundance at *Ballinamuck*, eastward of Longford town.

BRICK-CLAY.—Near Granard, a bad red brick, 20s. to 25s.; $9 \times 4 \times 2\frac{3}{4}$; weight, 7 lbs. Near Longford, 30s. to 32s.; $8\frac{1}{2} \times 4 \times 2\frac{3}{4}$; weight, 4½ lbs. Some few years ago a large trade in bricks and tiles was started in Longford, the bricks being sent by canal and rail to Dublin and elsewhere. This industry, however, had to be discontinued, on account of the prohibitory railway rates and the unnavigable state into which the Royal Canal was allowed to fall.—(*Parl. Comm. Irish Industries*, 1885, p. 578).

LOUTH.

BRICKS of red colour are made in many places, from one to four miles from *Ardee*; 24s. to 32s.; $9 \times 4 \times 3$; weight, 7½ lbs.; and $8\frac{3}{4} \times 3\frac{7}{8} \times 2\frac{7}{8}$; weight, 6¾ lbs. In various places in the vicinity of Drogheda bricks are made; they are from inferior to good in quality; 26s. to 33s.; $9 \times 4\frac{1}{2} \times 3$; weight, from 6 to 6½ lbs. Good red bricks near Dundalk; 30s.; $9 \times 4\frac{1}{2} \times 3$; weight, 6½ to 7 lbs. Dundalk bricks have been largely used in Belfast and in other towns.

MAYO.

"Clay fit for porcelain and every other description of earthenware is found in inexhaustible beds, and cargoes of the finer sorts are shipped for England. Fuller's earth and pipe-clay are also abundant, and very good clays for bricks abound in every barony." (*Lewis*, 1837, vol. ii., p. 356.) At the present time it is hard to verify the localities above referred to; but probably they may have been situated in Erris, as there is a tradition that clays were formerly shipped from Killala and Ballina.

BRICKS and TILES of a grey colour are made in several places in the vicinity of *Ballina*; bricks, 20s. to 30s.; $8\frac{3}{4} \times 4\frac{1}{2} \times 3$; weight,

6 to 7 lbs. Cushlough, two and a-half miles from Ballinrobe, 20s. to 30s.; $9 \times 4 \times 2\frac{1}{4}$; weight, $5\frac{1}{4}$ lbs. Different places near Swineford, pale-red bricks; $9 \times 4\frac{1}{4} \times 2\frac{3}{4}$; weight, 6 lbs. Lisconnell, two miles from Swineford, pale-red bricks, ridge- and drainage-tiles. Near Westport, as it would seem, no bricks have been made, although there is good clay in the vicinity. The detritus from the slate workings, if ground up, ought to burn into excellent brick. When the town was being built, bricks were imported from Liverpool at a cost of £3 per 1000.

FIRE-CLAY.—Beds of this clay of good quality occur in the small outlying Coal-measure patches near Balla.

MEATH.

Feriferous POTTER'S CLAY occurs at *Knock*, in Morgallion barony, formerly wrought into coarse earthenware. A pottery was also once at work at *Gravel Mount*. At *Brownstone*, four miles south-east of Navan, a "valuable stratum of Potter's clay"; and at *Dunshaughlin* "a superior Potter's clay."

BRICKS.—*Knock*, ten miles from Kells; good quality; red; 20s. to 30s.; $9 \times 4\frac{1}{4} \times 3$; weight, $6\frac{1}{4}$ lbs.; also superior flooring-tiles. *Killeary*, nine miles from Kells; same colour, quality, and price; also ridge and other tiles. *Athboy*, good quality; yellow; 25s. to 35s.; $9 \times 4 \times 3$; weight, 7 lbs. Similar bricks made at *Castletown*, eight miles from Navan. *Oldcastle*, in several places; 20s. to 25s.; $9 \times 4 \times 3$; weight, 7 lbs. None of these bricks seem to have ever been in the Dublin market, although suitable.

In this county, in the vicinity of Kingscourt, county Cavan, first-class bricks are now being made from the Keuper marl and clay in the drift; red; panelled; $9'' \times 4'' \times 3''$; free from lime; equal to the Bridgewater, and slightly darker in colour; superior for facing; they have rapidly taken their place in the Dublin market; at kiln, facing brick 38s., stock 30s.; in Dublin from 47s. to 50s. per 1000; here are made also unglazed kitchen-tiles, in two sizes, 9 and 6 inches square.

MONAGHAN.

POTTER'S CLAY and unctuous earth near *Castleblayney*; and at *Glaslough*, where a glazed pottery was made. Potter's Clay also occurs in *Tydavnet* parish.

BRICKS of a good quality are made at one to four miles from *Carrickmacross*; 27s.; $9 \times 4\frac{1}{4} \times 2\frac{3}{4}$; weight, 7 lbs. In several places near *Castleblayney*, 20s. to 25s.; $8\frac{3}{4} \times 4\frac{1}{4} \times 2\frac{1}{2}$; weight, 7 lbs. Near *Clones*, of poor quality; 25s.; $8\frac{3}{4} \times 4 \times 2\frac{1}{2}$; weight, $4\frac{1}{2}$ lbs. In the vicinity of *Monaghan*, 20s. to 30s.; $8\frac{1}{2} \times 4 \times 2\frac{1}{2}$; weight, $6\frac{1}{2}$ lbs.; and in other places.

"Elsewhere the clays of the drift, cleared of the stones, are made into an inferior class of brick."—(G. S. M.)

QUEEN'S COUNTY.

POTTER'S CLAY has been found in different places, and has been worked a little near *Abbeyleix*. At *Mountmellick* a most extensive pottery for coarse ware, such as crocks, tiles, garden-pots, &c., was carried on for a number of years; these works, in later years, turned out a vast number of drainage-tiles. At *Arless*, *Killieran* parish, there was a manufacture of roofing-tiles, formerly extensively made to supply the Dublin market, before the great introduction of slate into that city. This industry died out entirely in 1840.

BRICKS of good quality are made in great quantities in different places in the low country west of the Barrow; those in *Graigie*, a suburb of *Carlow*, being intended principally to supply that town; 18s. to 20s. Large quantities are conveyed by the Grand Canal to Dublin, New Ross, Waterford, and intermediate places. The "Athy brick" has already been mentioned (*ante*, p. 378).

At *Forest* and *Clonsast*, and in several places near *Mountmellick*, a poor, yellowish-red brick.

FIRE-CLAYS.—These have not been utilized (*see KILKENNY, ante*, p. 379).

ROSCOMMON.

In various places in this county there are clays suitable for TOBACCO-PIPES and coarse POTTERY. Near Roscommon town there have been several small potteries. At *Kilmain*, three miles S.S.E. of Roscommon, a small pottery, from local clay. *Knockcroghery*, very ancient works, tobacco-pipes, and pottery. The whole county of Roscommon has long been supplied thence with coarse earthenware.—(G. S. M.)

In the townland of *Curries*, south-east flank of Coarse Top, a large pottery was once worked, the bed of clay being three feet thick. Smaller potteries were rather frequent in the neighbourhood. Nothing is now known of them but their sites, marked on the Ordnance Map.

Along the shore of *Lough Ree*, especially near St. John's Point, are clays locally manufactured into tobacco-pipes. *Tubberpatrick*, N.N.W. of Strokestown, very fine Potter's clay.

BRICKS.—Neighbourhood of *Boyle*; fair class; grey; 18s. to 25s.; $8\frac{1}{4} \times 4 \times 2\frac{3}{4}$; weight, 5 to 6 lbs. In different places near *Castlereagh*, grey; 20s. to 25s.; $8\frac{1}{4} \times 3\frac{3}{4} \times 2\frac{1}{2}$; weight, $4\frac{3}{4}$ lbs. *Wakefield*, four miles from Roscommon; grey; not very good; 20s.; $8\frac{1}{2} \times 3\frac{3}{4} \times 2\frac{3}{4}$; weight, $4\frac{1}{2}$ lbs.

FIRE-CLAY (see CAVAN, ante, p. 371).—Fire ware was manufactured at *Arigna* when the iron and coal were being actively worked there.

SLIGO.

M'Parland, writing in 1801, states that "brick-clays," fine and fit for pottery, occurs where the Sligo road departs from Lough Gill, proceeding to Ballintogher.

BRICKS are made at *Lough Gill*, about three miles from Sligo, Collooney, and Dromahaire; price, 20s. to 22s. per 1000; average size, $8\frac{1}{2} \times 4\frac{1}{4} \times 2\frac{1}{2}$; weight, $5\frac{1}{2}$ to 6 lbs.

FIRE-CLAY.—(See CAVAN, ante, p. 371).

TIPPERARY.

PIPE-CLAY.—*Loughloheny* and *Ballymacadam*, south-east of Cahir; pipe-clay, associated with lignite. Formerly it sold freely on market-days in Clonmel, Cahir, &c., principally for cleaning soldiers' belts, &c.; it was also exported as Potter's clay.

POTTER'S CLAY.—Killenaule.

BRICKS.—One mile north-west of Cashel, as pointed out by O'Kelly, bricks are made from a bed of shale at the base of the *Coal-measures*. "The shale is dug up and exposed to the air, when it rapidly decomposes into a kind of tenacious yellow clay."—(G. S. M.) 20s. to 25s. per 1000; $9\frac{1}{2} \times 4\frac{1}{2} \times 2\frac{1}{2}$; weight, 6 lbs. Near *Clonmel*, 30s.; $9 \times 4 \times 3$; weight, 6 lbs. Near *Nenagh*, about 25s.; $9 \times 4\frac{1}{2} \times 3$; weight, 6 lbs. *Drumakeem*, four miles from Roscrea, 22s.; $9 \times 4 \times 3$; weight, $6\frac{3}{4}$ lbs. On the banks of the Suir, about one mile from Thurles, 20s.; $9 \times 4\frac{1}{2} \times 3$; weight, $6\frac{3}{4}$ lbs. Near Tipperary, a poor red brick, 25s.; $9 \times 4 \times 3$; weight, $7\frac{1}{2}$ lbs.

FIRE-CLAY.—In the *Tipperary*, or *East Munster Coal Field*, the fire-clays do not seem to have been as well developed as in Leinster; neither do they appear to have been utilized.

TYRONE.

POTTER'S CLAY, manufactured into good flooring- and ridge-tiles, coarse earthenware, and flower-pots, at Moy and Killymoon.

"About Fintona good flooring- and ridge-tiles are made; also garden-pots and a great variety of crockery ware for country use."—(*M'Parland*, 1802.)

In the drift in the vicinity of Coal Island and Lough Neagh there are clays which, according to Hardman, are suitable for brick-making; but at the same time he points out that the bricks

of the neighbourhood are in general made from the more clayey boulder-clay, "which has to undergo a sort of clarifying process, by being thrown into a pond of water, so that the pebbles and blocks sink to the bottom, and the finer mud, when it has subsided, is selected."—(G. S. M.)

Ballygawley, dark colour, 15s. to 20s.; $9 \times 4 \times 3$; weight, 7 lbs. *Cootestown*, 18s. to 23s.; $9 \times 4\frac{1}{2} \times 3$. *Coal Island*, of different qualities; best, 25s. to 30s.; inferior, 20s. to 25s.; fire-brick, 40s.; flooring-tiles, &c. *Gortin*, bright red; hard; an excellent brick; made only for the local trade; 11s. to 12s.; $9\frac{1}{4} \times 4\frac{1}{4} \times 3$; weight, 7 lbs. *Omagh*, not good; 15s. per 1000; $9 \times 4 \times 3$; weight, $7\frac{1}{4}$ lbs. *Strabane*, red, hard; sent to Derry and various other places; 18s.; $9\frac{1}{4} \times 4\frac{1}{4} \times 3$; weight, 7 lbs. *Drumnalong*, from 5 to 7 miles from Derry; very good; 15s. to 20s.; $8\frac{1}{2} \times 4\frac{1}{2} \times 2\frac{1}{2}$; weight, 6 to $6\frac{1}{2}$ lbs.

FIRE-CLAY.—In the county Tyrone the beds of fire-clay are more numerous and thicker than elsewhere in Ireland. At the Greenagh Colliery pit the fire-clay was found to be four feet thick. In the clay-pit, townland of Derry, the clay was found to be of excellent quality; there is about eight feet of grey clay on one foot of black, and below the latter three feet of red and variegated, or a total thickness of twelve feet; while in the engine pit the clays are eighteen feet thick. They are used in the manufacture of fire-ware, and at the present time the Ulster Fire-clay Works Co. sell at Coal Island glazed sewerage pipes from 2" to 24" in bore, at from $7\frac{1}{2}d.$ to 14s. per yard; plain or butt joint-pipes, 20 per cent. less; compressed flooring-tiles, octagon and square, according to sizes, from 12s. 6d. to 25s. per 100; black or red centres, from 5s. to 7s. 6d.; chimney-cans, according to size and finish, from 1s. 6d. to 7s. 6d.; sewer-bottoms, from $7'' \times 14''$ to $23'' \times 24''$, at from 3s. 3d. to 6s. 6d. per lineal yard; flue-covers, from $15'' \times 9'' \times 2''$ to $24'' \times 24'' \times 3''$, at from $6\frac{1}{2}d.$ to 3s. 6d. each; blast coke and puddling furnace-blocks, cattle and glasshouse-blocks, D-shaped round and oval gas-retorts; unpressed fire-bricks, 55s. to 60s. per 1000; pressed, 65s. to 70s. per 1000; white-faced, 80s. per 1000; chamfered paving-bricks, 65s. to 70s. per 1000; vent-linings; oncomes; wall-, cope-, and ridge-tiles, horse-mangers

and feeding-troughs. The prohibitory railway rates harass this industry.

At one time the Coal Island clay was made up into small oblong cakes, about a pound each, which had a ready sale as a substitute for Fuller's earth.

In the Annaghone Coal-field, which lies to the north of the main field, there is a considerable thickness of good fire-clay.

WATERFORD.

POTTER'S CLAY occurs near *Dungarvan*, *Ringagonagh*, *Lismore*, and *Whitechurch*; while PIPE-CLAY is found at *Ballyduff*, near *Dromana*, and *Ballintaylor*. Very little use, however, is made of it.—(*Lewis' Top. Dict.*)

"BRICKS are made about one and a-half miles above Waterford, at both sides of the Suir, from clay raised in the marshes; sold at the kilns from 25s. to 27s. per 1000; average size, $9 \times 4 \times 3\frac{1}{2}$, and weight 5 lbs. They are of bad quality, all the good bricks coming from *Youghal*, Co. Cork. In the mediæval English walls and towers round Waterford city bricks similar to what are now made were used; but none are found in the more ancient walls." (*James Budd.*)

"I have seen ancient pipes that were found in a rath; they were small, with bowls about three-quarters of an inch high. In Waterford city pipes have always been made within living memory; a few are made there still. The clay used was English (*Poole, &c.*). as the Irish clay contains either sand or iron; the sand could be washed out, but the iron could not always be got rid of, and often showed after the pipes were baked. Pipe-clay from *Ringagonagh*, and *Ring*, near *Dungarvan*, appears tolerably pure." (*James Budd.*)

WESTMEATH.

Very inferior bricks made in the flats of the Shannon, near Athlone; 18s. to 20s.; average size, $8\frac{1}{2} \times 4 \times 2\frac{3}{4}$; weight, $5\frac{1}{2}$ lbs. Castlepollard, a very fair brick, 20s. to 25s.

WEXFORD.

POTTERIES.—*Carleybridge*, Urrin River, near Enniscorthy, coarse pottery; *Oilgate*, between Wexford and Enniscorthy, flower-pots, &c. *Clohan*, south-west of Enniscorthy, pottery and tiles.

In very many places in the lowlands of this county there are extensive beds of *brick-clay*, which have been more or less locally used. They were worked considerably in the neighbourhood and vicinity of Wexford, especially near the College of St. Patrick, where Mr. Maddock manufactured bricks, enamelled tiles, &c. The best bricks were from 30s. to 35s. per 1000; average size, $9 \times 4 \times 3$; drainage tiles of five different sizes, 20s. to 60s.; and six-inch square red-and-black tiles, at 1s. per dozen. At one time there was a large trade in the flooring-tiles; but the workmen (English) could not keep themselves straight, and gave so much trouble, that Mr. Maddock gave up the works.—(G. S. M.) Inferior bricks, 20s. to 25s.

Enniscorthy, good quality, 18s. to 20s.

Courtoun Harbour.—Here is an excellent clay in quantity, but the lower portion is a bed containing minute particles of limestone that cannot be washed out, and pass unbroken through the crushers. This layer or bed has by different owners, from time to time, been mixed with the superior clay, thus deteriorating the brick. The present proprietor, Mr. Funge, is careful to prevent this. The bricks at present in the market are, in general, $9 \times 4\frac{1}{2} \times 2\frac{3}{4}$; but all shapes and sizes are made to order. Price at kiln, 25s. to 40s., according to quality; railway rate to Dublin, 11s. Ridge-, roofing-, and flooring-tiles of different sizes, from 6d. to 5s. per dozen, according to size and quality; also drainage-tiles.

WICKLOW.

BRICKS.—*Ballykelly*, three miles from Shillelagh; inferior; 18s. to 20s.; average size, $9 \times 4 \times 2\frac{1}{2}$; average weight, $6\frac{1}{8}$ lbs.; near *Bray*. Bricks were formerly made in various places near *Arklow*, but at present only at *Templenary*. Once a large business at *Ballybeg*, near Rathnew, and *Inchanapper*, near Ashford, &c.

VI.—GRANITE, ELVAN, PORPHYRY, FELSTONE, WHINSTONE, AND METAMORPHIC ROCKS OF IRELAND.
By G. H. KINAHAN, M.R.I.A., ETC.

[Read May 16, 1888.]

INTRODUCTION.

THE eruptive and metamorphic rocks were chronologically classified by me in a Table accompanying Chapter XIII. of the "Geology of Ireland" (1878); and on further research I find no reason for material changes, although some minor modifications are necessary, such as the proposed classification of these rocks in Antrim as Eocene, on account of Mr. Starkie Gardner, Prof. Asa Gray, and other American palæontologists declaring that the plants found in the associated tuffose beds (*Iron measures*) are of Eocene and not Miocene types. The possible age of the exotic rocks of the S.E. of Ireland is now given for the first time. With these modifications the following Table has been brought up to the present state of our knowledge.

On account of the changes in nomenclature since 1878, when the first Table was published, some of the names have to be altered to those in the Table of Geological Strata, as given in page 8, *supra*.

In the following Table the 1st column indicates the different formations with which the eruptive rocks are associated in Ireland. In the 2nd column is given the general classification of the eruptive rocks, to which metamorphic granite is added, so that it may be seen in what formations and localities the gradual change from unaltered, through metamorphic, into the eruptive rocks can be best studied. The remaining columns give the districts, or TERRITORIES, into which it seems most convenient to divide the country. In them the sign * denotes the existence, the sign ? the probable existence, of the rocks in the TERRITORY indicated; while the columns are left blank when the rocks of the class are not represented, or are supposed not to be represented.

TABLE OF THE ERUPTIVE AND GRANITIC ROCKS AND METAMORPHIC GRANITE.

Formation.	Group of the Rocks.	S.E. Ireland.	Munster.	Galway and South Mayo.	North Mayo and Sligo.	Ulster.	Carlingford District.
EOCENE, . . .	5. Doleryte, euryte, and felstone (Trachyte), . . .	?	—	?	?	?	?
	4. Elvan, . . .	—	—	—	?	?	?
	3. Intrusive triclinic felspar granite, . . .	—	—	—	—	—	?
	2. Intrusive monoclinic felspar granite, . . .	—	—	—	—	—	—
	1. Metamorphic granite, . . .	—	—	—	—	—	—
TRIASSIC, . . .	5. Doleryte, euryte, and felstone, . . .	?	—	—	?	?	?
	4. Elvan, . . .	?	—	—	?	—	?
	3. Intrusive triclinic felspar granite, . . .	—	—	—	—	—	?
	2. Intrusive monoclinic felspar granite, . . .	?	—	—	—	—	?
	1. Metamorphic granite, . . .	—	—	—	—	—	—
CARBONIFEROUS, .	5. Melaphyre, euryte, and felstone, . . .	?	?	?	?	?	—
	4. Elvan, . . .	?	?	—	?	?	—
	3. Intrusive triclinic felspar granite, . . .	—	—	—	—	—	—
	2. Intrusive monoclinic felspar granite, . . .	?	—	?	—	—	—
	1. Metamorphic granite, . . .	—	—	—	—	—	—
DEVONIAN AND SILURIAN,	5. Melaphyre, diabase, euryte, and felstone, . . .	?	?	?	—	—	—
	4. Elvan, . . .	?	?	?	—	—	—
	3. Intrusive triclinic felspar granite, . . .	—	—	—	—	—	—
	2. Intrusive monoclinic felspar granite, . . .	?	—	?	—	—	—
	1. Metamorphic granite, . . .	—	—	—	—	—	?
LLANDOVERY AND ORDOVICIAN,	5. Diabase, euryte, quartz-rock, and felstone, . . .	?	—	?	?	?	?
	4. Elvan, . . .	?	—	?	?	?	?
	3. Intrusive triclinic felspar granite, . . .	?	—	?	?	?	—
	2. Intrusive monoclinic felspar granite, . . .	?	—	?	?	?	?
	1. Metamorphic granite, . . .	—	—	?	?	?	—
ARENIG AND CAMBRIAN,	5. Diabase, euryte, quartz-rock, and felstone, . . .	?	—	?	?	?	—
	4. Elvan, . . .	?	—	?	?	?	—
	3. Intrusive triclinic felspar granite, . . .	?	—	—	—	—	—
	2. Intrusive monoclinic felspar granite, . . .	?	—	—	—	—	—
	1. Metamorphic granite, . . .	?	—	—	—	—	—

Some of the granitic and eruptive rocks are eminently suitable for rubble work and walling; others for paving-sets, or kerbs or quoins; others for cut stone purposes; and the more valuable for polished work in monuments, pillars, slabs, chimney-pieces, &c.

Granites have been used both in ancient and modern times, and when well selected are an excellent and durable material. But it is evident that builders have frequently looked more to the easy and rapid completion of their work than to its durability, as has already been pointed out (page 209, *supra*) in reference to sandstone. This employment of undurable materials is instanced in many of the early ecclesiastical buildings and others in or margining the Leinster granite range, and in the more modern buildings in Dublin, for example, where good cut-work has lost all its sharpness on account of the stone disintegrating under the action of the weather. In Dublin this is not now so observable as it was forty or fifty years ago; as since then many of these crumbling edifices have been removed or re-faced. Well-selected stones have, however, stood the test of time in both ancient and modern structures, to which attention will be hereafter directed.

From time immemorial the granite boulders have been very generally used for various purposes—as for instance in the erection of the megalithic monuments and structures, especially in the so-called *cromleacs*, and in the fabrication of the *bullaulns*, or stone basins, found in many places.

[The *bullaulns* are usually more common in the neighbourhood of the ancient ecclesiastical settlements than elsewhere. They were probably employed in various ways; e.g. as mortars in which to bruise or crush corn, apples, &c., as baptismal fonts, &c. Some that are built into the walls of the churches may have been either fonts or holy water stoups. At Roscam, near Galway, the late Dr. William King found a peculiar oval pestle that exactly fitted one of the neighbouring *bullaulns*, and may possibly have been made for it. In the counties Clare, Limerick, Tipperary, Queen's County, Wexford, and Wicklow, where some years ago much cider and perry was made for exportation, we find many of the cup-querns that were used for crushing the apples or pears, wrought out of granite erratics. In modern times, in Leinster especially, boulder stones have been extensively worked up into monuments, gate-posts, steps, sills, farm-rollers, &c. Erratics from the Leinster granite occur in the counties Kilkenny, Carlow, Kildare, Dublin, Wicklow, and Wexford; while in the King's Co., Tipperary, Galway, and Mayo, the granite blocks seem to come principally from the country north of Galway Bay; such have been found even in the counties of Cork and Waterford. Elsewhere in Ireland, according to the published records, the spread of erratics from the granite centres does not seem to be very observable; but in the neighbourhood of Ramelton, Co. Donegal, fifty years ago, there were numerous

granite blocks on the drift-hills, which seem to have come from Barnesmore. Most of them were split up and utilized, principally in connexion with the quay and other improvements in Ramelton. Others occurred on the slate quarry hill near St. Johnstown, about nine or ten miles S.W. of Derry.

In the Co. Donegal at the present time bowl-shaped corn crushers, or *bullams*, are in use for bruising oats for home purposes, and malt for distillation. These *bullams* are generally wrought out of granite or gneiss boulders; but sometimes they have been cut in the solid rock; often in quartzite, or quartzitic sandstone. In all cases the pestles now in use are of wrought-iron, made by country smiths.]

Polished Irish granite has of late years come into the market. Blocks procured from different places have, indeed, from time to time been used in monuments; but the first permanent trade seems to have been established in the neighbourhood of Newry. A trade in polished granite was carried on for a few years at Dungloe, Co. Donegal, which it is now proposed to revive; special quarries have been opened near Galway town; while the rocks of the well-known Termon quarries, Blacksod Bay, Co. Mayo, are now to be put on the market for polished work.

In the quarries worked near Newry (Cos. Down and Armagh) the rocks are bright and uniform greys; those near Galway are of very variable and unusual colours, with shades of red, green, yellow, and chocolate, all more or less clouded and spotted; while those from Blacksod Bay and Dungloe are brick-red, salmon, and grey, with white. Near Dungloe they are capable of being raised in blocks of large sizes. From various other places good stones have been procured and polished; but as yet no quarries have been opened.

GRANITE POLISHING WORKS AND QUARRIES.

Ulster Steam Polishing Company, Belfast, John Robinson & Son. Quarries, Castlewellan and Goraghwood. Mottled and fine bright greys (p. 473).

Newry Polishing Works, H. Campbell & Son. Moor Quarries. Mottled and fine bright greys (p. 473).

Bessbrook Granite Co., T. W. H. Flynn. Quarries, Bessbrook, Camlough, and Derranore. Mottled medium and bright greys. Rostrevor, Hewitt. Green (whinstone) (p. 472).

Mayo Granite Co., now being formed. Quarries, Termon Hill, Blacksod Bay. Greys, red, and salmon (p. 443).

Donegal Granite Co., now being formed. *Quarries* in the neighbourhood of Dunglow. Bright-red, greys, and white (p. 455).

Galway Marble Works, John Millar & Son. *Quarries*, Bal-lagh, Shantallow, Letteragh, and other places near Galway. Porphyritic and mottled reds, pinks, greenish-pink, yellowish, and chocolate (p. 441).

Arklow Sett Quarries, C. S. Parnell. *Quarries*, Arklow rock. Mottled green (granitone or dioryte); not in the market (p. 420).

Carnsore, Co. Wexford, Lord Keane's *Quarries*, Carne and Carnsore. Reds, and at the latter a course of delicate flesh-colour; not as yet in the market (p. 427).

Architects do not always use polished granites judiciously. Some stand the weather much better than others; and the latter, often more or less beautiful, are more suited for inside than for outside work. From an examination of outside polished works in Ireland, England, Scotland, Canada, and the United States, I find that many of the granites employed in outside polished work are not suitable therefor, especially some of the largely crystalline varieties. The harder and more compact the stone, the more lasting the polish.

[In Ireland the stones that seem best for retaining their polish are basalts and some of the other hard whinstones, if they do not contain iron, very silicious granite, quartz-rock, and quartzite, as these, after ages of exposure, have retained the polish wrought on them during the glacial period. Such whinstones and granites would be costly and difficult to work, and few persons now-a-days would like to go to the necessary expense. Somewhat similar remarks might be made in reference to quartz-rock and quartzite; the latter rocks, however, will not dress, nor even saw, across the grain.]

A granite quarry, to be profitable, ought to be able to produce large blocks suitable for monoliths and all sorts of monumental purposes, stone for all description of cut-stone work, paving-sets, kerbs, and channel stones; while the detritus should be ground up into coarse sand for the manufacture of blocks for paths and roadways.

For building, especially cut-stone purposes, the *Intrusive Granites* are usually much superior to those of *metamorphic origin*; as in the former, with but few exceptions, there are systems of what the quarrymen call "grains." These are lines, often recognizable only by trained eyes, along which the stones readily split. In

general, there are two systems of "grain," at right angles to each other; and under such circumstances the stones can be split into rectangular blocks, or else slabs, of from a few inches to several feet in their various dimensions. Stones of this class are nearly always capable of long and heavy bearings, while they can always be dressed on any face. On the other hand, granites of solely metamorphic origin seldom have a regular "grain." If there be a "grain" it is always along, and never across, the planes of foliation; and such granites are unsatisfactory for fine cut-stone purposes, as they dress only on one face. But as they are hard, durable stones, and can usually be raised in large sizes, they are admirably suited for heavy work, where permanency rather than finish is required. To this general rule there is an exception, as some of the rocks, originally intrusive granite, and afterwards foliated by subsequent metamorphic action, seem to retain, more or less in their new state, their original "grain." The granitic gneiss, which is considered to be the most durable of all the stones that have been used in New York city, appears to belong to this class of metamorphosed intrusive granite; as do also the granites along the margin of the Slieve Croob intrude, Co. Down, and certain granites in the Castlebar and Lough Conn district, Co. Mayo.

The relations between the Irish granitic gneiss, or foliated granites, and their associated schists, are at present only partially understood.

The granites due to metamorphic action, whether called "foliated granite," "granitic gneiss," or "gneiss," in Iar-Connaught, Co. Galway, and in the barony of Kilmacrenan, Co. Donegal, are in no place intruded into the associated schists. It is therefore evident that they must be adjuncts of the schists, and not rocks that were intruded into the schists. In these portions of those counties there are, however, associated with the tracts of metamorphic granitic rocks and schists, newer granites that have been undoubtedly intruded subsequently to the formation of the metamorphic granites and their associated schists.

At the extreme south of the barony of Boyleagh, with the adjoining part of Banagh, Co. Donegal, in the Lough Conn district, Co. Mayo, in the Slieve Croob district, Co. Down, and in south-east Ireland (Leinster granite range) the relations

between the granites and the associated schists are different from those in Galway and Kilmacrenan.

In north-east Mayo, Lough Conn district, the foliated granite, or granitic gneiss, sends dykes and courses into the associated schists. It is therefore evident that these granites were originally newer than the associated rocks; while subsequently all were simultaneously foliated, the granite, as a mass, being newer than the schists, but the last foliation in all being developed by one and the same force. In the barony of Boyle, Co. Donegal, the greater part of the foliated granites occurs similarly to those of Kilmacrenan. But at the extreme south of that barony, in the Glenties district, there are other foliated granites which seem to be of the same class, and to occur more or less similarly to the granitic gneiss of north-east Mayo.

In the Co. Down the Slieve Croob granite was intruded into the associated sedimentary rocks, while subsequently the margin of the intrude, and a belt around it, were invaded by metamorphic action, and foliation developed simultaneous in both; the strikes and dips of the foliation in both being similar.

In the oldest granites (Post Ordovician) of the Leinster range there are two distinct structures allied to foliation. The first of these is locally known as the "grain" of the granite, it consisting of systems of parallel planes along which the rock splits easily. This structure is often more or less obscure, and only to be recognised by the eye of a practised quarryman; but in some places, especially in the counties Carlow and Wexford, it is very conspicuous, giving the rocks a gneissose aspect. This structure, when traced to the margin of the granite, is found to be quite distinct from the foliation of the schists, the first striking more or less obliquely at the latter.

The second foliation found in the oldest Leinster granite is confined nearly solely to the S.E. margin between Aughavannagh (south of Lugnaquilla), Co. Wicklow, and Killiney, Co. Dublin. This structure, as in the Slieve Croob granite, seems to be parallel to the margin of the intrude, and in places it strikes parallel to the foliation of the associated schists. The latter, however, is not always the case, as in some places the foliation of the schists strikes at the margin of the intrude. In this area there were at least two newer granites after the intrusion of the oldest of the Leinster range.

As has been mentioned, and as will be more particularly referred to when describing the different granite areas, a very general characteristic of the intrusive granites is a structure similar to the "grain" in the oldest granite of the Leinster range.

SUMMARY.

The Galway granitic gneiss, or foliated granite, and the similar rock in the Co. Donegal, are not found intruded into the associated schists.

The granitic gneiss of N.E. Mayo, and certain courses in the Glenties district, Co. Donegal, are found intruded into the associated schists.

The Slieve Croob granite, Co. Down, and its associated elvans, were intruded into the associated schist prior to foliation being developed in it.

The oldest (Post-Ordovician) granite of the Leinster range is intruded into the associated schists. The structure called the "grain" possibly was developed during the cooling; and it is perfectly independent of any structure in the associated schists, while the schistosity along the S.E. margin seems in part to have relations to the foliation in the adjoining schists.

Elvans and porphyries and some felstones often have characteristics more or less allied to those of the intrusive granite. But they are seldom capable of being raised in blocks of large scantling; and many of them are not suitable for long bearings. Some of them, however, break up naturally into squarish blocks, eminently suitable for building purposes; they usually dress and saw well; while some of them, when polished, are handsome stones. A few of the polished stones lately brought into the market by the Millars of the Galway Marble Works are allied with or belong to this class. Some of the felspathic rocks (*granulyte*) should be eminently suitable for the manufacture of glass.

The whinstones, including the granitic or coarse varieties (*granitone*, &c.), often break up more or less irregularly, some being rubbly; others, however, make good building-stones, or are suitable for cut and even polished work. As already pointed out, polish on basalt and other whinstone is very durable if the stone does not contain much iron. When of good quality, these can be

finely worked on any face, are of fair scantlings, and are capable of long and heavy bearings. Many of them split readily into good durable paving-sets of suitable sizes. The stones in dykes and intrudes invariably split better than those in contemporaneous beds.

The metamorphosed whinstones, the "*hornblende rocks*" of Macculloch, are more or less granitoid. They can be raised in massive blocks very suitable for coarse work, such as piers, sea-walls, &c. Of late, ophytic varieties have been introduced into the London market, under the trade name of "green granite." These are principally from Sweden and Norway. But more recently, Mr. Flynn, of the Bessbrook Granite Company, has been manufacturing a green stone obtained at Mr. Hewitt's quarry, Rostrevor, Co. Down; while Mr. Parnell has exhibited a very handsome mottled stone from Arklow rock, Co. Wicklow.

These different varieties of hornblende and allied rocks are not uncommon in West Galway (Connemara); while they have been also recorded from places in Mayo, Donegal, Tyrone (near Pomeroy), Down, Armagh, Louth, Wicklow, Wexford, and elsewhere.

[The granitoid (or granite-like) hornblende rocks often partake, more or less, of the nature of ophyte (*serpentine*); some, indeed, being highly crystalline ophytes. This class of rock is usually found in tracts of highly metamorphic rock, such as those of Galway, Donegal, and Tyrone; but sometimes they occur elsewhere. In the metamorphic regions, where ophytes occur, there are also usually in connexion with them, or as independent masses, ophytic hornblende rocks of a granitoid aspect, like the Swedish rocks. Up to the present time no special attention has been called to these, and only rarely have they been recorded; but wherever ophytes occur, it is highly probable that they also will be found. Further on, in the different TERRITORIAL DESCRIPTIONS, the places where they are known to exist, or are likely to be discovered, will be mentioned. At present, however, as no quarries have been opened, nor trials made, it cannot be said if they can be procured of suitable dimensions. A very necessary qualification is that they be free from iron, as otherwise they are liable to discolouration and weathering.]

In the mechanically formed adjuncts of the volcanic rocks, such as the agglomerates and tuffs, there are some good building-stones suitable for cut-stone purposes. Many of them have already been described among the calcareous rocks and the sandstones; but they will again be referred to in their different localities.

Some felstones, whinstones, and tuffs have been changed into ophytes (*serpentine*) and steatytes (*soapstone*); they, with the allied camstones (*Pyrophyllite*), have already been described in my

Paper on Marbles (page 157, *supra*). Some of the steatytes and camstones have been locally used for lining furnaces and the like; but as yet there has not been any regular trade in them, although they seem capable of being cheaply wrought into fire bricks.

Typical quartz-rock (*Greisen*, COTTA) is sometimes apparently an intruded rock. On account of its usual splintery, rubbly nature, it is not generally fit for building purposes, except for the rudest walls.

Gneiss is generally a hard, durable stone; and some, if regularly jointed, can be raised in naturally square blocks of both large and small scantling, suitable both for heavy and for light work. It is capable of long and heavy bearings. This rock is usually difficult and expensive to dress, quickly wearing out the tools. All samples will dress on the foliation surfaces; but many will not dress, though some may be sawn, across these.

Good schist, like slate, is durable, and if naturally jointed makes good building-stones, as it rises in more or less flat-bedded blocks. In some places the mica schists are ferruginous (*ferriferous micalyte*) and rapidly assume the appearance of having been burnt.

Many of the fine-grained, or the close granites, are eminently suitable for paving-sets, on account of their hardness and the readiness with which they split, as also some of the elvans and whinstones; but in order to be useful in this way, the stone must not only split easily into the required sizes, but it must not be liable to become slippery when worn by traffic. Many stones, eminently suitable for paving in all other respects, become dangerously slippery, even after a little wear.

A practice has been lately introduced of breaking up the waste of granite quarries into gravel and sand for walks, or for the manufacture of granite concrete blocks for streets, drives, and walks. This granitic concrete is much superior, in every way, to asphalt; but it has not come into general use, being much more difficult to repair when a pathway is cut across to lay down water, gas, or other pipes. This, however, might be remedied if the concrete were manufactured in narrow blocks, say eighteen inches wide, one course of which might be raised without interfering with the rest.

GLASS.—The granulyte (veins of segregation) in the Killiney and other Dublin granites, when fine-grained, highly felspathic, and nearly micaless, as also the nearly similar elvans in the marginal micalyte, have been pronounced suitable for use in the manufacture of ornamental and bottle glasses.

Similar elvans, as hereafter mentioned, occur in Cos. Kildare, Carlow, and Kilkenny, west of the granite range; while associated with the laccolites at Little Rock, Arklow, further north at Lewis Ville, Kilbride, as also in Croaghan Kinshella, and neighbouring hills, there are fine elvans similar to, if not identical with, the Devonshire granulyte now (1888) imported by the glass-bottle makers of Ringsend, Dublin.

For the convenience of description, Ireland may be divided into four TERRITORIES, namely—(1) the *Leinster*, or *south-east*; (2) the *Munster*, or *south-west*; (3) the *north-west and north*; and (4) the *north-east* [excluding Antrim, put, for convenience, into (3)]. These limits have been regulated as much as possible with reference to the affinity of the *Exotic rocks* in each of them to one another. The above division agrees in the main with this affinity; except in regard to the last two divisions, the later rocks occurring in both. This, however, is so partial that it does not disturb the general arrangement.

In this, as in my earlier papers on the *Economic Geology of Ireland*, I am indebted for much information to previous writers, and to numerous correspondents, to whom again I return sincere thanks; as often as possible the names of the local contributors are given in connexion with their information, thus authenticating the various statements.

LEINSTER, OR SOUTH-EAST IRELAND.

Chronological Account.

[Queen's Co., King's Co., Kildare, Dublin, Wicklow, Carlow, Kilkenny, Wexford, Waterford.]

As indicated in the Table (page 392, *supra*), the granitic and allied rocks in south-east Ireland are of different ages, and are varied in character and composition. Prior to giving the TERRITORIAL DESCRIPTIONS, it seems advisable to treat of the rocks chronologically, more fully than could be done in the Table.

CAMBRIAN and ARENIG (?) Whinstones, Eurytes, Felstones, and Quartz-Rocks, with granitic roots (?)

In the Co. Wexford these rocks are more usually metamorphosed (schist, hornblende rock, gneiss, and granitic rocks). Elsewhere they are not as numerous, and are unaltered.

[Some of the whinstones and quartz-rocks (*Greisen*, Corra) were evidently intruded or accumulated contemporaneously with the associated Cambrians; sometimes as bedded sheets, sometimes in protrusions, on and around which the sedimentary rocks were deposited. As adjuncts to these, there seem to have been granitic roots (*skans*, &c.); these, however, are difficult to trace out satisfactorily, on account of the surface accumulations. In the Co. Wexford and elsewhere, it is apparent that, in the later formations the whinstones (*gabbro*, *diabase*, &c.) were associated with masses of agglomerate. Some altered masses of whinstones, with their adjuncts of Cambrian age, are the rocks that have been picked out by Dr. Callaway, and declared to be of Archaean age. The greater part of the quartz-rocks are unquestionably Cambrian, as to their material (we cannot now stop to go into this question); but some of the dykes may be of later age, as similar rocks are found extending up into the Ordovicians. It is therefore clear that there must be older and later quartz-rocks, and that consequently the exact age of isolated exposures cannot be positively stated. In the granite, in some places in the Co. Wicklow, there are masses of quartz-rock specially peculiar, from having in them an independent structure, indistinguishable from bedding: this is very conspicuous in the "White Rock," a little north of Tinahely. Some at least of these masses are contemporaneous with the granite, such as the mass near Hacketstown, which graduates into a conglomeritic rock, and the latter into the associated granite. In general, however, the mass of the quartz-rock has a hard, well-defined boundary, the strike and dip of the lines of structure being regular.]

ARENIG (*Post-Cambrian* and *Pre-Ordovician*). In the Co. Wexford, at Carne, Carnsore, and in the Saltee Islands, there are intrusive and metamorphose granites, later than the accumulation of the Cambrians, and older than that of the Ordovicians. These have not been recognized as occurring in any other part of this territory.

ORDOVICIAN, Whinstones, Eurytes, Felstones, Quartz-Rocks, and their granitic roots.

[The granitic rocks in the laccolites (*Gilbert*) or root masses, are in general very felspathic, often hornblendic (*synnyte*); but whether hornblendic or micaceous, their minerals are in very minute crystals or flakes, especially the latter, which are often so minute as only to be microscopically perceptible. In the early accumulations (*Black Shale Series*) there are quartz-rocks, sometimes as protrudes, but usually as dykes, some being felspathic. In the middle group (*Ballymoney Iron Volcanic Series*) whinstones, (*diabase* and *gabbro*) are frequent in protrudes, bedded sheets, and dykes. They are often associated with tuffs, which are more or less calcareous, and some even impure limestones. There are also some peculiar protrudes of agglomerate, a few being in mass, but in general they are of smaller dimensions. The latter are invariably more or

less calcareous, containing, in some places, nodules of limestone, while in others they merge into impure limestone. That these were contemporaneous protrudes is probable, because in places they extend into interbedded sheets and lentils. In the upper group (*Kilmichael* or *Slate Series*) there are also whinstones generally occurring as protrudes, or intrudes (?), some of which have been changed by methyloitic action, into serpentine (*ophyte*), soapstone (*steatite*), or some allied rock. The exact age of the youngest intrusive rocks is uncertain, as where they occur there are no rocks newer than Ordovician, by which their age might be determined. Some, however, are probably of later than Ordovician age, as hereafter mentioned. Jukes appears to have been the first to point out that some of the schists, especially the hornblendytes, are metamorphosed intrusive rocks. Usually, if a course of whinstone has been metamorphosed, the central rib is changed into hornblende rock or hornblende gneiss, while the margins have become hornblendyte (*hornblende schists*). Matthews, of Baltimore, when writing of the American rocks, suggests the alteration to be due to metamorphosis, or molecular displacement, and Dr. Teall more recently has come to a similar conclusion. Examples of such alterations can be seen in the courses of whinstone in various places in the more highly altered rocks of S.E. Ireland (Dublin, Wicklow, and Wexford), those of Connaught (Galway, Mayo, Sligo, Leitrim, &c.), those of Ulster (Donegal), and in those of North America (Dominion and States). In other places that I have not seen similar changes may have taken place. Some of the ophytic-hornblende rocks, among the highly metamorphosed rocks, are very similar in aspect and composition to the so-called "Swedish green granite."]

Materials for Glass.—Associated with the masses of exotic rocks there are, in places, granites which graduate into elvan; some of the latter, already mentioned, as at the Little Rock, Arklow, are very felspathic, and eminently suitable to be used in the manufacture of glass. Some of the elvan veins, and the granityte veins in the Leinster granite, or in its vicinity, are also very felspathic, and might be similarly utilized.

LLANDOVERY, or MAY HILL SANDSTONE (*Post-Ordovician* and *Pre-Silurian*). Granites, Elvans, Quartz-Rocks, Felstones (?)

[In the Leinster hill range the granites are lithologically very varied, but petrologically they seem to be divisible into the following, viz.:—LEINSTER TYPE; the AUGHOWLE TYPE, or *Pegmatyte*, similar to that occupying the parish of Aughowle; and the AUGHRIM TYPE, best seen in the vicinity of Aughrim.

The "Leinster Type" granites (*Haughton*) are evidently the oldest, and seem to be intrusive, the date of their intrusion being after the accumulation of both the Cambrians and the Ordovicians. They have all the general characters of an intrusive granite, and at their margins break up through the schist. Nevertheless, in various places, such as Scullogue Gap, between Mount Leinster and Blackstairs, and elsewhere, there are in the granite, seams, or lenticular beds of schists, coinciding in strike and dip with the "grain" of the granite. These are difficult to account for in an intrusive mass; yet that the mass is intrusive seems unquestionable; because if we cross the strike of the "grain" at right angles, this grain is found to be oblique and unconformable to the stratification of the marginal schists. When describing these inliers of schist in the

country margining Mount Leinster, Jukes suggests that they "are mere tongues of mica-schist and gneiss, let into the granite while that was yet fluid, portions of that molten matter being, at the same time, squeezed and injected between the beds of the aqueous rocks for some distance, all this taking place of course while the two rocks were buried deeply under many thousand feet of superincumbent rock." (c.s.m.) The grain so characteristic of intrusive granite is probably introduced by thrusting.

[NOTE IN PRESS.—Since this was in type, a report on the N.W. Highlands of Scotland by the officers of the Geological Survey of Scotland has been published in the *Quarterly Journal of the Geol. Soc. Lond.*, vol. xliv., No. 175, pp. 378, &c. In this Paper the effect of thrust in producing foliation is very exhaustively explained, and such thrust would explain the "grain" in the Leinster granite. As, however, the different systems of thrusts that have from time to time affected the rocks of this territory have still to be worked out, we cannot here refer further to the subject.]

The Leinster range granite, as pointed out by Jukes, seems always to be margined by rocks of Ordovician age, and never by the older Cambrians. The Ordovicians to the eastward of the great granite intrude were altered by *metapexis*, or regional *metamorphism*; those to the westward of the range by *paroptesis*, or contact *metamorphism*. Towards the western margin, especially, but also in smaller tracts elsewhere, there is *growan*. Portions of this *growan* are evidently decomposed Leinster Type granite; but some of it, especially in the Co. Dublin, seems to be composed of "Aughrim Type granite." This latter granite is evidently much newer than the former, and it is supposed to be of either Devonian or Carboniferous age, perhaps even later. Generally the Leinster Type granite is more or less even-grained, but some of it is porphyritic.

Associated with this granite are intrudes of QUARTZ-ROCK, as at the White Rock, northward of Tinahely.

The ELVANS and the FELSTONES, the adjuncts of the Leinster Type granite, cannot be satisfactorily traced, being so much obscured by drift; they occur in the associated schistose rocks.

Some of the whinstones in the schists are also probably adjuncts of the Leinster Type granite; this, however, can only be suggested, as it has not as yet been proved.

AUGHOWLE TYPE GRANITE, OR PEGMATYTE.—This forms a considerable tract in the parish of Aughowle, at the junction of Carlow and Wicklow. The rock is a pegmatyte, made up of large crystalline pieces of quartz and felspar (often microcline), with flakes of mica. The rock is not recognized in the country as a granite, but is called "some sort of a bastard rock." In aspect it is somewhat similar to the pegmatyte of Ontario and Pennsylvania, in which are situated the "mica mines;" but, unfortunately for the home country, the veins of mica in the Aughowle pegmatyte are of very small dimensions. In the mass of the rock the mica is usually on the faces of the felspar. The *Plumose granite* of Jukes is a variety of this pegmatyte, in which the mica is arranged like plumes of feathers. This pegmatyte is similar to the *endogenous granite* of Sterry Hunt, which he considers is due to the deposition of minerals from solution in open veins or spaces. If this was the origin of the Aughowle pegmatyte, there must have been in the granite mass a large cistern full of water, highly charged with mineral

matter, which was gradually being deposited as the water evaporated. In the associated Leinster Type granite, especially to the southward, the composition of the "endogenous veins" is more or less similar to that of the Aughowle pegmatyte. The exact limits of the Aughowle pegmatyte are uncertain, the rocks being so much concealed by drift.

The *growan* used to be largely sold in the city of Dublin, under the name of "free-stone," for domestic purposes. The disintegration of the Leinster Type granite, especially that of the Co. Carlow, seems to be due in a great measure to the contained quartz being made up of acicular particles; but at the same time there must be some peculiarity in the felspar that causes it also to decompose; possibly the mica also may have peculiarities. The disintegration of the Aughrim Type granite seems in a great measure to be due to the quantity of marcasite in it, and to the white mica (*margarodite*?). Growan is an excellent fertilizer on limestone soil, or on the tracts of limestone drift. As pointed out by Haughton, most of the rich lands of the Co. Carlow are due to the admixture of granite and limestone debris.

The growan due to the disintegration of the Leinster Type granite ought to be useful in the manufacture of china and coloured glass; but it does not appear to have been tested.]

DEVONIAN (?), CARBONIFEROUS, TRIAS (?), EOCENE (?). Granites, Elvans, Felstones, Eurytes, Whinstones.

[The rocks in Croaghan, north of Philipstown, King's Co., are a protrude of carboniferous age; but the ages of the other later exotic rocks in the same district are more or less open to conjecture. The granite of the AUGHRIM TYPE may occur as outliers in the schistose rocks, as it does near Aughrim and Rathdrum, or in different places as intrudes in the older granite (*Leinster type*). Under the latter circumstances, on account of the paucity of natural or artificial sections, it is difficult to separate one variety from the other; but J. Chaloner Smith, when reconstructing the railway between Kingstown and Killiney, observed and pointed out two distinct classes of rocks, one evidently of much later age than the other—the later rocks occurring as intrudes partly in the old granite and partly in the mica schist.

The exact age of this granite is uncertain. It may be *Silurian*, or *Devonian*, of a similar age to the volcanic products so well represented in the provinces of Munster, Connaught, and Ulster; or it may be of the same age as the just mentioned Croaghan protrudes (Carboniferous), or even of that of the Mourne Mountains granite (*Triassic*). There is no petrological evidence by which its age can be determined; but lithologically it has affinity to the Mourne granite, being slightly albitic—so it may possibly be of similar age (*Triassic*).

The *Aughrim type* granite is an even, free-working stone, jointed in squarish blocks, and having two "grains," along which it splits easily. It is very pyritous (*marcasite*), and liable to disintegrate in concentric coats; so that the outer parts of a block may be much affected by weathering, and liable to peel off in spheroidal shells, while the middle part of the block may be quite sound. A constant adjunct of the intrudes is the "iron masking" of the neighbouring rocks. These seem to have been impregnated with a solution that deposited marcasite, and this, by rapid decomposition, has stained the rocks, which, from their appearance, are locally called "burnt rocks."

These *burnt rocks*, connected with the intrudes of the Aughrim type granite, are similar to the "burnt rocks" containing the mineral channels of the Cos. Wicklow and Wexford, which formerly led me (page 108, *supra*) to suggest that the

intrusion of this granite and the formation of the mineral veins were contemporaneous, that is, belonging to one and the same period of vulcanicity.¹ The mineral veins, however, did not accumulate all in a moment; the great "sulphur lode," as also all the other lodes, with one or two slight exceptions, are made up of thin laminæ, parallel to the "foot-wall," and more or less oblique to the "hanging-wall;" consequently it is evident that the shrinkage fissures, now occupied by the lodes, opened very gradually, the lodes being augmented successively by very thin parallel laminæ. The formation of the fissure may have been due to this vulcanicity, the fissure giving opportunity for the production of the lode, and the filling stuff being leachings from the surrounding mineral-charged rocks. In one of the deepest workings in the *East Ovens Mines* (Cronebane) the lode is cut out by an intrude of granite.

In some few places adjoining the intrudes of the Auhgrim type granite there are ribs, or narrow strips, of the associated rocks, which have been changed apparently by "local metamorphism" into gneiss. Ribs and patches of altered jasperized, or baked rocks, often occur isolated; the ribs are peculiar, and seem to be due to aqueo-igneous heat, which found a passage along a line of fissure or jointing. Some of these altered rocks, which are very felsitic (leptinite, or white-stone), will be mentioned further on.]

In places in the granite and schist areas there are newer dykes of whinstones and felstones, which Du Noyer suggested might possibly be of Tertiary age. Some of the whinstones are very like the melaphyres of the Croaghan protrude (in King's Co.); and in places they are cut and displaced by fissures filled with, of course, later felsytes. I have elsewhere suggested the possibility that these melaphyres and felsytes may be adjuncts of the intrudes of the "Auhgrim type" granite.

Territorial Description.

INTRODUCTORY.

In the *Queen's Co.* there are no known exotic nor metamorphic rocks.

In the *King's Co.* and *Kildare* there are isolated exposures of eruptive rocks; Carboniferous whinstone (*melaphyre*) and tuff at *Croaghan*, north of Philipstown, and at The Chair, to the northward of the town of Kildare; very little used.

¹ According to the Australian miners and geologists (*see* Jack's "Report"), burnt, or "iron-masked" rocks, as they call them, are favourable to the occurrence of gold. This may have some bearing on the existence of the gold of the Co. Wicklow, as "iron-masked" rocks occur in the water-sheds of the valleys in which the "placers" are situated; but, at the same time, gold is not recorded from the tracts in which the greatest masses of these "iron-masked" rocks occur.

Extending south-westward from Dublin Bay to near New Ross on the River Barrow, in the Cos. *Dublin, Wicklow, Kildare, Carlow, Kilkenny, and Wexford*, is the great Leinster surface exposure of intrusive granites, with outlying smaller exposures to the S.W. in Kilkenny, and to the eastward in Wicklow and Wexford. In the last-mentioned county, in the Carnsore district, a considerable proportion of the rock is granitic gneiss (*granite of metamorphic origin*).

South-east, south, and south-west of the Leinster granite range, in the Cos. Wicklow, Wexford, Waterford, Kilkenny, Carlow, Kildare, and Dublin, there are in the Cambrian, Ordovician, &c., beds, sheets, masses, and dykes of doleryte (?), melaphyre, diabase, euryte, felstone, and elvan; the probable ages to which each belong having been already discussed. Most of the older ones are more or less altered; some being also changed by methyloitic action into serpentine (*ophyte*), soapstone (*steatyte*), or other allied rocks.

[The methyloitic rocks have already been tabled and described in the Paper on IRISH MARBLES AND LIMESTONES (pp. 156-164, *supra*).

In the area of the Leinster granite range, the granite is generally used for all building purposes; but in the Co. Wexford, in the neighbourhood of the granite outliers, that rock is rarely used, the houses, walls, and fences being built of clay.

When quarries are opened the stones are rarely used, except for farm fences and road material; for the latter a quarry will not be opened if gravel can be obtained, even though it may have to be carted for miles. In places where very superior road metal could be easily procured by quarrying in the granite or whinstone, this will not be resorted to, although the roads have to remain nearly impassable in consequence.]

The granite varies greatly in quality; some of it is very coarsely crystalline, some very fine; it is of every degree of durability; some hard durable varieties are good for tool work, others not so. Their different qualities will be mentioned in connexion with the different quarries and districts. In some places the granite in use is procured solely from loose blocks and erratics; the latter in places occurring in greater or less quantities outside the limits of the granite areas. Formerly the granite of those districts, where it has two "grains," along which the stones split readily, with plugs, into rectangular pieces, was in great demand, being easily and cheaply wrought into columns, pillars, farm-rollers, posts, sills, jambs, &c., procurable in considerable lengths, and capable of long bearings. Of late years, however, it

has become the fashion to use iron articles instead of granite for many of these purposes.

Neither the felstones nor whinstones, seem to have been much utilized in ancient or modern times. There are, however, some green tuffose rocks, very durable, that dress easily and well, and were used in the old structures. The beautiful doorway of the old church at Clone, near Ferns, Co. Wexford, illustrates the work they are capable of; as also some carving in the Seven Churches, Glendalough.

CO. DUBLIN.

GRANITES.

The granite of the Co. Dublin, as a general rule, is not considered to be well adapted for cut-stone purposes, on account of the difficulty of working it into mouldings; and a freer working stone procured from Golden Grove and Ballyknockan, Co. Wicklow, has been generally preferred and used; nevertheless, as the sequel shows, there has also been a large consumption of the material obtained near Dublin.

Dublin is largely flagged with granite slabs: these have been principally wrought from the erratics and loose blocks, or from small quarries on the flanks of the Three Rocks and neighbouring hills. These blocks have been also extensively worked into quoins, and sometimes used for dressed-stone purposes; but for the latter they were generally unsuitable, as shown by the disintegrated condition of much of such work. Within the last two or three decades many of the old dressings have had to be removed and replaced.

Moreover, the stones quarried for flagging used to be, and are still, badly selected, as will be seen by the uneven weathering of the slabs in the pathways. Of late a most undesirable trade has sprung up in granite for common walling purposes and other cheap work; the stones being supplied by the farm occupiers, who raise the stones in slack time, and during winter cart them down from the Dublin hill slopes. This practice is very injurious to the repute of the Dublin granite, as the stone thus procured soon becomes weathered and discoloured. Some of the window-sills, &c., quite disfigure, on account of their dirty colour, many of the newly erected houses in the suburbs of Dublin. These cheap stones have

done away with the former trade in limestone ; so that most, if not all of the quarries of the latter, which were formerly worked to supply Dublin are now closed, such as those in the Kimmage district, to the southward, and those between Lucan and Leixlip to the westward (page 173, *supra*).

[NOTE IN PRESS.—Some of these limestone quarries have been reopened for use in the piers of the Loop line Railway connecting Westland-row and Amiens-street.]

The *Killiney, Bullock, Dalkey, and Kingstown Quarries*.—The granites here are harder and more durable than those of Wicklow and Carlow ; but as the latter tool more freely, and can be procured at cheaper rates, they have been preferred by the Dublin builders. The local stones are capable of being raised in very large blocks, and were extensively used during the building of the Kingstown piers and jetties, they having been procured from two quarries, now filled up, near the land end of the East Pier, and from extensive workings in the north face of the *Telegraph Hill*. Stones from these quarries were also used extensively, by the permission of the Board of Works, in the construction of the permanent way, the old stations, and the old offices of the Dublin and Kingstown railway.¹

In the neighbourhood of Bullock and Dalkey, granite has been largely quarried in different places, for use in the public and private buildings of the neighbourhood of Kingstown and elsewhere. Various light-houses round the coast, as that at the south entrance to Bearhaven, Co. Cork, were built by the Ballast Board of stones procured here, while Kylemore Castle, Connemara, the seat of Mitchell Henry, Esq., which was contracted for by a Dublin builder, although close to the great granite area of Galway, has facings and dressings of “Bullock granite.”

The granulyte (or veins of segregation in the granite), when fine-grained, felspathic, and nearly micaless, as also the nearly similar elvans in the adjoining mica schist, have been pronounced suitable for use in the manufacture of ornamental and bottle glass (page 317, *supra*).

During late years, a very good class of granite was quarried at

¹ The newer works at the Kingstown and Dublin Stations are of Ballyknockan stone.

the *Glenageary Railway Station*, to build the *Townhall, Kingstown*. It is a handsome streaked stone, which works easily and well. The quarry was closed after the work was completed.

A good class of granite has also been lately quarried near *Dundrum*, and used largely in *Dublin*.

"In the bridges, and harbour, and quay works, *Dublin*, we have used *Killiney* and *Bullock* granite most extensively; also *Penrhyn*, *Dalbeattie*, and *Newry* granites—all good stones, when properly selected. The *Dublin* mountain granite is generally coarse-grained, full of mica, and decays rapidly in comparison with the *Killiney* stone." (*B. B. Stoney*.)

Wilkinson states:—"The granite at *Kingstown* is much more durable than the *Blessington* (Co. *Wicklow*) stone; but the latter is of a more pleasing and lighter colour, is easily converted, and is, besides, generally prepared on the spot by local workmen, at a cheaper rate than it could be wrought in *Dublin*."

[The latter portion of *Wilkinson's* statement would seem to suggest the advisability, as a general rule, of having the stone wrought at the quarries, and not at the building which is being erected. This is controverted by an eminent architect of the present day, who has publicly stated that the stone should be brought to the building, and manipulated under the eye of the architect.

The disadvantage and loss due to stone being wrought at the works, and not in the quarries, may be seen at the present moment in the works now being carried on during the erection of the buildings for the *Science and Art Museum, Kildare-street, Dublin*.

The stone being used for the finer work is sandstone, from *Mountcharles, Co. Donegal*, it being brought from the quarry in squared blocks. As little waste as possible is allowed; yet in cutting out a column or pillar at the works there is a loss of one-fifth of the block; and if it is a capital or other such feature that has to be executed, there is a much greater loss. There is also the primary cost of squaring the blocks in the quarry; so that if a bad stone is sent up, it has become too costly to be thrown away, and must be used, although faulty, as is ocularly demonstrated in the south-west corner column of the new building.

If the stones were wrought at the quarry there would be the following savings:—The cost of the squaring of the blocks, the cost of the carriage of the waste, and the increase in the rate of wages necessarily paid in *Dublin*. The ancient *Egyptian*, *Roman*, and other builders, and even the early *English* and *Irish* ones, were more sensible than those of the present day;¹ as they not only wrought the stones at the quarries, but even cut columns and such like out of the rocks *in situ*, as is now done in places in the *United States*.

There is the expense of supervision, on which great stress has been laid; but whether the work is done in the quarry or at the building, superior operatives have to

¹ *Ballyknockan granite quarry, Co. Wicklow, and places in Carlow, Wexford, &c., are exceptions to this rule, as presently mentioned*

be employed—men who can use their own judgment, and are not solely depending on the architect; so that on this score there will be no great difference as to expense.

It appears, therefore, as has been proved at the Ballyknockan and other granite works in the Leinster range of hills, that the cutting and dressing of the stones can be more economically performed at the quarry than at the edifice which is being erected.

All the stonecutters in Wicklow, Carlow, Kilkenny, and Wexford, seem to be also smiths, having their small forges in which they repair their jumpers, chisels, hammers, wedges, &c.; the tools blunted during a day's work being renovated at night, to be ready for use next day.]

The principal granite structures in Dublin, when Wilkinson wrote in 1845, were the *Parliament House*, at present used as the offices of the Bank of Ireland, flanking walls. *Trinity College*—new buildings, Co. Wicklow granite; upper part of Library refaced with similar rock in place of sandstone (later about 18 rows of columns of Wicklow granite were erected in the open corridors beneath the Library to support its floor.) *Post Office*—facings, Dublin and Wicklow granite. *Rotunda*—Wicklow and Kilgobbin granite; the latter in bad preservation. *King's Inns*—facings, Wicklow granite. *Four Courts*—facings from Golden Hill and Kilbride, Co. Wicklow; entrance-gate and walls, Co. Dublin granite; this last now much decayed. *Custom House*—some of the facings in chiselled granite, in good preservation. *Castle*—entrance-gate and some of the dressings, much decayed. *Nelson's Pillar and the Wellington Testimonial*—Glencullen and Kilgobbin granites which seem to have been well selected, and have stood well. (The O'Connell Monument, Glasnevin, was also of Glencullen granite, selected by Jukes.) *St. George's Church*—walls faced with Dublin granite. *St. Paul's Church*—Glencullen stone. *St. Werburgh's Church*—columns, &c., which are much decayed. *St. Thomas's Church*—dressings and facings. *Metropolitan Church*, Marlborough street—faced with Dublin granite. *St. Francis Xavier's and St. Paul's*—porticos, entablatures, pediments, towers, &c., Ballyknockan, Co. Wicklow. Wilkinson specially calls attention to the very good examples of Grecian, Ionic, and Roman Ionic work in the capitals of the pillars of these structures. Since 1845 granite has been used in the following buildings as well as in others:—

Stock Exchange, Anglesea-street—Ballyknockan. *Gate Piers*, *St. Stephen's-green*—Ballyknockan. *North Wall Branch of Bank of Ireland*—Ballyknockan; colours very uniform. *Porch at National Insurance Office*, Dame-street—Ballyknockan. *Fountain*

at *O'Connell's Bridge*—Goragh Wood granite. Pedestal of *Dargan's Statue*, Leinster Lawn—part of a granite boulder from Ballagh, Galway. *Mercer's Hospital*—facings of new wing; rough scabbled Ballyknockan granite. *St. Peter's Church*—new facings, rough scabbled Ballyknockan granite; dressings, sandstone. *Science and Art Museum, Kildare-street*—dressed facings, Dublin and Ballyknockan granite. Some of the stones seem to be badly selected. *Museum Buildings, Leinster Lawn*—Dublin granite, seems to have been well selected. *Saint Anne's Church*—facings, &c., Ballyknockan, with limestone and sandstone string courses. *Saint Andrew's Church*—rubble facing, Dublin granite, limestone dressings. *Unitarian Church, Stephen's-green, West*—rough-picked Dublin granite; facings, dressings, &c., limestone and sandstone. *Methodist Church, Stephen's-green, South*—columns and portico. *Blind Asylum Church, &c., Leeson Park*—Buttresses, out Ballyknockan; facings, rough Dublin; windows, &c., limestone. *Methodist Church, Charlestown-road, Rathmines*—dressings, Ballyknockan; facings, badly selected Dublin granite. *Methodist Church Temple-road, Upper Rathmines*. *Westland-row Railway Station*—facings, dressings, &c., Ballyknockan. *Trinity College, new Medical Schools and Museum*—facings, dressings, &c., Ballyknockan. *St. Andrew's Church*—Ballyknockan? and Dublin. *Loop Line*—caps of piers and springings, Aghrim and Dublin. *St. Patrick's House, S. Circular-road*—facings, a poor Dublin granite. Also string-courses, wall-caps, window sills in most of the brick houses, Wicklow and Dublin; the latter, in the new structures, generally badly selected.

The stones that have been used by the *Ballast Board* in the quays and other works have been already mentioned.

[The granites which are principally used at the present time for cut-stone purposes are from Ballyknockan, Stepaside, and Glencullen. *Ballyknockan*, about 4s. per cubic foot in the rough; carriage about 6s. per ton; all cartage by road; about 11 cubic feet to the ton. *Stepaside*—sills 1s. 4d. per lineal foot, in squared blocks, about 2s. 6d.; cost of working into sills, steps, quoins, &c., about 1s. 2d. for Stepaside, and 1s. 6d. for Ballyknockan; moulds and chamfering, about 1s. 3d. more for working Ballyknockan than Stepaside. All cornices, string-courses, sills, columns, &c., extra to cubic dimensions. *Aberdeen* sent only wrought, price about double Ballyknockan. *Goragh Wood* mostly used for monumental purposes. (*R. Clarke.*)]

The employment of a bad-class of Dublin granite, especially in the new buildings in the suburbs, cannot be too highly censured.

Some of these stones, after a few years' exposure, have already disfigured what would otherwise be chaste structures; while in some forty or fifty years, or even less, most of this granite will be more or less decayed.

In connexion with the Leinster granite range there are in many places, as already mentioned, surface-stones on the granite ground and on the marginal metamorphic rocks. These have been very generally utilized, being easily split and worked; and, as hereafter more specially mentioned, different places have got a character from these stones, which have not been obtained from any quarry, but solely from erratics of good quality accidentally found therein. Outside of the Co. Dublin the principal quarries are in the Cos. Wicklow and Carlow; and although Wexford and Kilkenny stones are well known, there does not seem to be any workings that could be called quarries in these counties.

Quarry near Dundrum.—Recently opened, very fair stones, but requiring to be well selected.

Goldenball and Kilgobbin.—Small quarries in different places, and surface stones, about eight miles from Dublin; where they have been extensively used for flagging and quoins, and formerly for dressed work. Good stones can be procured by selection, as shown by the Wellington Testimonial, Phoenix Park. "Grey, usually largely crystalline; quartz and felspars about equal; mica olive colour." (*Wilkinson.*)

Killiney and Ballybrack.—Small quarries in various places; about eight miles from Dublin. "Best stones, light grey, very felspathic: mica black-and-green. The stones are very variable, belonging to the older and later granites, and have to be carefully selected." (*Wilkinson.*)

Kingstown and Dalkey.—"Very variable in quality and texture; from highly crystalline to fine, and from very hard to friable; shades of grey; in the coarse varieties grey and black mica; in the fine, black mica grey quartz and whitish felspar. In some varieties there are crystals of sphene (*Titanite*)."
(*Wilkinson.*) Some very fair veins of stone were cut when the railway between Kingstown and Killiney was re-constructed; used in the Dalkey, Bray Head, and Greystones Coastguard stations.

Glencullen.—Good bright colour; free working. "The Glencullen granite is a favourite with builders, on account of moderate

prices and quick delivery. On account of its quality and cheapness it has been used in different coastguard stations in Louth and Dublin in preference to the local limestones." (*M. Mellon.*)

In the coastguard stations along the east coast the dressings and other cut-stone, especially for long bearings (steps and sills) have been largely procured in the Co. Dublin. *Glencullen granite*, "Clogher Head, Co. Louth; Rush and Malahide; Ringsend, with some *Dalkey stone*; here they were also used for facing; at Arklow, Co. Wicklow, and Kilmichael Point, Co. Wexford, with *Aughrim stone*. Ringsend, with *Glencullen stone*; Dalkey, Bray, and Greystones, Co. Wicklow, with *Kingstown stone*, the first being also faced with punched ashlar; while the Bray building is faced with very superior rubble. (*M. Mellon.*)

All the authorities speak of the Dalkey and Kingstown stones as very durable. Many of the Glencullen stones disintegrate freely; but, if well selected, stand well, as in St. Paul's Church, &c., Dublin.

WHINSTONES, EURYTES, FELSTONES.

In the *Ordovicians*, to the north of the Co. Dublin, near Balbriggan, Donabate, and on Lambay Island, as also in the southern part of the county, near Saggart and Rathcoole, and in the *Cambrrians* of Howth, there are dykes and other intrudes, principally of eurytes—that is the rocks intermediate between whinstones and felstones, being neither predominantly basic nor acidic. They may be of the same age as some of the newer eruptive rocks in the Cos. Wicklow, Wexford, and Waterford; but the precise age of the eruptive rocks near the northern end of the great Leinster granite range is not known; however, they are post-Ordovician and pre-Carboniferous. Some varieties, such as that known as the "Lambay porphyry," are a handsome, mottled, green stone, capable of taking a good polish. Specimens were exhibited by the late Lord Malahide at different times, some being now in the Dublin and other Museums. The Messrs. Sibthorpe never heard of it being in the market; but pieces can be obtained by favour, and have been manufactured into paper weights and table slabs of from 12 to 16 inches in diameter. At different times during the last 30 or 40

years, some of these stones have been suggested as good for "paving-setts." They work readily, as they split squarely and easily; but most of those that have been tried seem to have a soapy quality (*steatitic*) which is detrimental, as they would be slippery if subjected to traffic. [*Vide Papers on Irish Arenaceous Rocks*, p. 205, and p. 219, *supra*.] In Howth, Saggart, and other places quarries have been opened to supply road metal to Dublin, the Townships, and the local roads.

In the neighbourhood of Balbriggan are many intrudes of whinstone, some of which Jukes considered to be specially suitable for paving-setts.

GNEISSES AND SCHISTS.

Gneiss, is nearly, if not altogether, absent from the Co. Dublin. On the margins of the granite intrude there is in places a thin coating, having a gneissoid appearance. It is scarcely, however, a typical gneiss, the foliation being rather of a platy structure, introduced in the outer crust of the granite.

The *schists* are various, both here and in the adjoining portion of the Co. Wicklow. They may be either metamorphosed igneous or sedimentary rocks. If they were originally felstones they are now felsitelyte (*felsite-schist*), or feldspathic *micalytes*; but if originally eurytes or whinstones, they are now, nearly always, some variety of *hornblendyte*.

[“The thick courses of euryte and whinstone, as already mentioned, have usually a compact rib margined by schist. This is, generally, not the case with felstone courses; although it has been recorded as occurring in the Co. Galway. Some of the metamorphosed felstone courses in that country, near the town of Galway, are a granitic rock along the margins, but have a felstone or porphyry rib.” (a.s.m.)]

In the schist districts this rock is extensively used for general purposes, especially the *micalyte*. It affords good serviceable stones, very durable; but some are unsightly, as they become by weathering “iron-masked.” *Micalytes* ought to be used much more than they are, in sea-walls and piers; because when they can be raised as rough flags in large, or even fair sizes, if they are pitched, not built, in courses in the walls, no wave can work them out; while if the walls are left rough enough on the face, waves cannot rise so well on them, as they would otherwise do.

[These qualifications of schistose, slaty, and shaly rocks can be studied in various places round the coast of Ireland. On natural sea-margins the waves rise much higher on a smooth surface than on a rough one, or on a perpendicular wall than a sloping one. A wave coming on a rock will rise much higher than on an adjoining shingle beach, and on a perpendicular rock-cliff much higher than on a sloping one. This, of course, is intended to apply only to more ordinary cases. If a sea-wall rises directly from water so deep that there is but little breaking of the wave-crests above it, the face of the wall should be perpendicular. This is well illustrated when a north-easterly storm is driving the waves against the perpendicular rounded end of the west pier of Kingstown Harbour.]

WICKLOW, KILDARE, AND CARLOW.

INTRODUCTION RESPECTING GRANITE.

[The granites of the north-west of the granite area, situated in Co. Wicklow (*Blessington district*), are much preferred by the Dublin builders to those of their own county, as not only are the stones kinder to work, but also, as pointed out by Wilkinson, they are wrought on the spot by native stonecutters, thus saving expense in various ways. We may again point out, on account of its importance, the advantage of cutting building stones at the quarry. *The stone can be cut more easily and cheaply when fresh than afterwards. The carriage to be paid for is solely that of the wrought stone, and not of blocks, a fourth or a third of which would have to be chipped away afterwards, while only sound stones are sent from the quarry. On the other hand, if the stone is sent in blocks, notwithstanding the most careful selection, some bad ones will escape detection; and these, after their carriage, will have become so costly that they cannot be thrown away, and have to be used to the detriment of the building.*

In the neighbourhood of Castledermot, Co. Kildare, and in the western part of the Carlow granite tract, the rocks are partly similar when sound; but in places tracts of growan come in. Some of this growan probably belongs to the newer granite; but a large portion is evidently disintegrated "Leinster type" (*Haughton*) granite.

At the junction of Carlow and Wicklow, near Shillelagh, in the district after which it may be called, is the *Aughowle pegmatyte*. This peculiar variety, already described (*ante*, p. 404), is so coarse and unsightly as to be suitable only for the very roughest field walls.]

In Kildare and in Carlow, both on the granite and on the marginal tract of schist, there are many granite erratics, now far less numerous than they were some years ago. These were formerly a considerable source of income to the occupying tenants, who split them up, and wrought them into pillars, earth-rollers, sills, window-stools, &c., or sold them to the stone-cutters and builders, who wrought them themselves. This trade, however, has greatly fallen away of late years, iron articles being used instead of stone in so many cases. The length of scantling supplied by these stones, and the long bearings of which they are capable, even with small transverse dimensions, are very remarkable.

These stones are very suitable for this class of work, as there are in them two systems of "grain," or concealed lines of splitting, in planes perpendicular to one another, along which the quarrymen can split the rocks, with plugs, to any required scantling.

[The operation of plugging, as practised in the south-east of Ireland, consists in making a row of round jumper holes, into which treble plugs are driven. If the stone is kind, the holes are from five to twelve inches deep, according to the size of the block; if the stone is tough, the holes must be deeper. Where a block has been split into slabs, these are again split with flat wedges into posts, sills, &c. Most of the inhabitants of these counties are quarrymen, and are skilled in splitting up the blocks, and many of them spend their spare time as stonecutters.]

In this area the granite, for the most part, is not what can be called a first-class stone, being often more or less rotten or flaky, or even a growan, so that good stones cannot be procured everywhere. Those places in which good stone is known to exist are mentioned below.

Although granite has been so generally used in recent times, yet, as pointed out by Wilkinson, "in the ancient buildings of Co. Wicklow, slate-rock was the material more generally employed, mixed with rolled field-stones of quartz and granite. . . . In the buildings at the Seven Churches, Glendalough, the granite blocks are in many places much corroded by the weather, while the slate-stones indicate, by their present state, a greater durability." Some of the quoins in St. Kevin's Kitchen are of granite, which rock was also partly used in the Round Tower, "the semicircular arch in the doorway of which is cut out of a solid block of granite. There is also a very peculiar and ancient archway constructed of granite, which forms part of a gate-house, through which an old paved road was constructed. Large flat-bedded stones of this road still remain. The peculiarly worked bed and arched joints of this gateway indicate a rude and primitive construction."

CO. WICKLOW.

GRANITES.

Golden Grove and Ballyknockan, near Blessington (Leinster type), generally known in the trade as "Blessington stone." Bright grey, more felspathic and more easily worked than the Kingstown and

Bullock granites, but not as durable. At first it is superior as to colour; but when wheathered, it is much the same in that respect as the others. On account of its ready dressing and of its being worked at the quarries by the native workmen more cheaply than it or any stone could be when carted to the buildings in course of erection, it has been largely used in Dublin. "Probably a better evidence of the difference in working quality, and of the value of the facility of conversion, as compared with the cost of carriage, could not be adduced than the station-house and offices at Kingstown, of the Dublin and Kingstown Railway, which, although built on the solid granite rock, are constructed with stone brought from near Blessington—a distance of twenty miles." (*Wilkinson*.) These granites have been already specially referred to.

In other places in this neighbourhood small quarries have been opened, and good stones procured; all, however, have gone into the market under the name of "Blessington granite," and none of the workings have been extensive enough to have received a special name; it is, therefore, only necessary to state that in this locality good stone could be procured in other places if quarries were opened. Elsewhere, in the tract of the granite of the "Leinster type," the quarries that have been wrought in different places seem to have been only for local use, or some special purpose, as the stone from these is not known in the general market.

Ballynaclash, S.W. of Rathdrum, a dyke of fine elvan; at one time worked for paving-setts, for which it ought to be suitable, if the quarry was continued in depth.

Carrick, south of Rathdrum (*Aughrim type*), "Fitzwilliam quarry." Grey, even-grained, but containing more or less marcasite, which causes discolouration, was extensively quarried during the construction of the railway from Dublin to Wicklow.

"*Aughrim*, close, fine, and easy to work, used with Glencullen granite, for sills, steps, and other dressings in the Arklow and Kilmichael (Co. Wexford) C. G. stations; and with Carlow granite in those at Curracloe and Rosslare, both in Co. Wexford. The Carlow granite is a good variety, soft and close, hard and coarse, good and bad colour." (*J. W. Mellon*.) Extensively used on the railway between Killiney and Kingstown; also on the "Loop Line," Dublin.

Tinnakilly, north-east of Aughrim, worked in different places. In

“Edward’s quarry” (opened by the contractor of the railway to Shillelagh), and thereabouts, the stone can be raised of very long scantling, and capable of long bearings ; the stone is otherwise very similar to that of Carrick.

Railway Quarry, near Aughrim station (*Aughrim Type*). More or less similar to the Carrick stone ; has been largely used at the Bray station, and in other places along the Kingstown and Wicklow Railway.

Shelton Abbey and Glenart, about a mile N.W. of Arklow. (*Elvan*). There are portions of a dyke in the Ordovician rock, broken and slightly shifted by the fault of the Ovoca River ; a bluish-greenish stone, weathering yellowish grey. The quarries were opened and used for building the out-offices at Shelton Abbey, and the castle and out-offices at Glenart.

Near Lewisville, north of Arklow. A boss of bright grey, fine-grained granite, has been a little worked for local purposes.

Little Rock, Arklow.—A bright grey, fine-grained granite ; used in the vicinity ; the felspathic elvan associated with this rock is suitable for glass manufacture.

Croaghan Kinshella.—On the north and north-west slopes, extending into the county of Wexford, is a fine-grained, bright grey granite, regularly jointed, of apparently a good quality. It has not been made use of, except the loose blocks of it for farm purposes.

Macreddan, four miles from Rathdrum. Hard, yet not very difficult to work.

Killanure, five miles from Shillelagh. Micaceous and quartzose ; even-grained ; works well.

Williamstown, seven miles from Baltinglass. Felspathic, black mica ; coarse-grained ; hard to work, as it splits irregularly.

Highfield, four miles from Baltinglass. A more easily worked and better stone than the last.

WHINSTONES, EURYTES, FELSTONES, QUARTZ-ROCKS.

In the north-western part of the Co. Wicklow, extending from the boundary of the Co. Dublin to near Baltinglass, there is a strip of *Ordovicians*, and associated intrusive rocks, very similar to those in Kildare, except, perhaps, that they are more altered. To

the eastward of the granite area, and lying unconformably against the Bray and Newtownmountkennedy tract of *Cambrians*, there are more or less metamorphosed *Ordovicians*. In these there are, apparently some interbedded masses, as also dykes and other intrudes of whinstone, euryte, and felstone; while in the *Cambrians* there are a few whinstones (*diabase*) and intruded courses of quartz-rock. The quartz-rocks in the granite area has been already mentioned.

The whinstones, eurytes, felstones, and quartz-rock, altered or unaltered, are very little used. In one place, as already mentioned (*ante*, p. 403), between Roundwood and Annamoe, a mass of whinstone has been altered into ophyte (*serpentine*), more or less allied to the so-called "Swedish green granite." "The towns of Carnew, Shillelagh, Arklow, Rathdrum, Wicklow, Newtownmountkennedy, and Bray, are situated in the slate district; and this stone has in these places been generally used for all buildings. The rock produces large, flat-bedded stones, and makes good strong rubble-work; but being thinly laminated, it is not well suited for cut-stone purposes, as it cannot be worked across the grain. Granite is therefore almost universally used for this kind of work." (*Wilkinson*.) Some of the towns enumerated above are in the *Cambrian* area, where the rock used is rough slate, not the *Ordovician* schist.

There are whinstones in different places suitable for paving-setts. At the Rathdrum railway station, as also to the east of the Ovoca River, there is a very similar stone: this was worked a little, but injudiciously, the surface-stones only being wrought, which gave the setts a bad repute. Further southward, or down the valley, opposite Avondale demesne, in the townland of Shroughmore there is a stone very similar to the Welsh stone so much used in Liverpool. A little S.E. of the Ovoca railway station, a whinstone is quarried for general purposes. Some years ago it was made into setts for the Dublin market, but was not approved of, as it was said to become slippery. A little westward of Wooden Bridge a quarry was opened by Mr. C. S. Parnell, and good setts made; but the undertaking had to be abandoned, as the agent of the property demanded too high a royalty.

Big Rock, Arklow.—On this hill Mr. C. S. Parnell has opened quarries. "Four varieties of whinstone are worked—three blue, and one slightly greenish. The setts made are—No. 1, 4" × 4" × 4";

No. 2, 5" × 5" × 5"; No. 3, 5" to 8" × 3" × 6; and No. 4, 5" to 9" × 4" × 7". The stones are not in sizes large enough for channels, kerbs," &c. (*W. Kerr.*)

To the north of Arklow, at the *Lewisville* granite, near *Snugborough*, and in different other places in the parishes of Kilbride, Ennereilly, Dunganstown, &c., there are stones of good aspect, but as yet untried. One variety rises in flags, and has been used for flagging in Arklow and the country farm-houses.

[The polish which the whinstones are capable of receiving and retaining can be studied by examining blocks and pieces in the glacial drift.]

Little Rock, Arklow, mass to the south of the hill. Nice-looking, mottled greenish, granitoid.

In the neighbourhood of the Ovoca mines there are great masses of "baked rocks" (*leptyn*ite and *granulite*) mixed up with felstone, and often difficult to distinguish from one another. Some of these rocks, as pointed out years ago by Weaver, are suitable for the manufacture of kaolin (*porcelain clay*), while others can be cut and polished. A specimen from Bell Rock, south of the mines adjoining the tramway, gave a nice, streaked and mottled, light dove-coloured stone, that cut well and took a fine polish. Very pure leptyn

ite, suitable for the manufacture of kaolin and of glass, occurs in various places adjoining the intrudes of whinstone; these felspathic rocks also occur, more or less isolated, as in the vicinity of the Ovoca mines. The latter have not been made use of, although attention was directed to them more than half a century ago by Weaver.

KILDARE.

GRANITES.

In the granite tract which lies to the south-east of the county, no large quarry has been opened in recent years on account of the number of surface-blocks of a superior class which occur there. The beautiful sculptured cross at Moyne, restored by the pro-

prietor, Mr. Frederick Carroll, was out out of a block of this granite, while the megalithic structures, commonly called crom-leacs, in this and the Co. Carlow, have in most cases huge granite blocks as cover-stones. The covering-stone of the Kernanstown cromleac measures 16 feet \times 13 feet \times 5 feet. (G. S. M.)

"The interesting and beautiful architectural ruins of Castledermot form one of the most extensive erections in which granite has been used for Gothic architecture. They are in the later pointed style of Gothic, commonly known as the Decorated style, and contain many well-finished and delicately-wrought mouldings, which show that granite is not unsuited to such work. The stone is generally in good preservation." (*Wilkinson.*)

Newtown, near the mearing of the county and the town of Carlow. Grey, free-working, even-grained.

Dairy-farm, south-west of Castledermot. Grey, fine-grained, easily wrought, capable of producing fine and elegant work; can be raised in blocks of considerable size and length. "Some of this granite was considered so good that it was sent to Dublin for columns." (G. S. M.) The columns and other cut-stone work in the portico of the Presbyterian Church, Arran-quay, Dublin, are said to have been wrought out of stone here procured.

Knockroe, south-east of Castleroe cross-roads. Light-grey, even-grained, black mica. (G. S. M.)

Hallahoise, south of Bushfield. Similar rock to last. (G. S. M.)

WHINSTONES, EURYTES, FELSTONES, &c.

Towards the N.W. of the Co. Kildare, at the Hill of Allen and the Chair of Kildare, in the *Ordovicians*, there are interbedded tuffs and eurytes: the latter, according to Jukes, being somewhat similar to the Lambay porphyry. Towards the N.E. of Kildare, coming in from the Co. Dublin, and forming a narrow strip along the N.W. mearing of Wicklow, there are also *Ordovicians*; those nearest the granite being metamorphosed; while associated with them are whinstones, eurytes, and felstones, similar to those in Co. Dublin, but perhaps not as numerous.

The intrusive rocks appear to be very little utilized; but the slates, schists, &c., are generally used for all common building

work. "The town of Naas is situated just on the border of the rocks, and is badly supplied with building-stones; cut-stone being generally obtained, either from the limestone, at some distance, or from the granite of the Wicklow range." (*Wilkinson.*)

CARLOW.

GRANITES.

In the north-eastern part of this county the granite is generally of a bad class, friable or coarse; but towards the western boundary of the granite tract, especially near Bagenalstown, some excellent stones have been procured, both from the surface-blocks and from quarries. Granite is the stone generally used, not only in this area, but also in the valley of the Barrow, to the eastward, for quoins, sills, gate-posts, walling, and all cut-stone purposes. It is also used for fences; split blocks 8 or 10 inches square, and about 8 feet long, being placed on granite pillars, of the same transverse dimensions. These fences are both durable and cheap, costing about 8s. to 10s. a perch.

"The Lunatic Asylum, Court House, Union Workhouse, and many other buildings in the town of Carlow, were erected of local granite, procured from different quarries. Can be had in nearly any scantlings. From hard to free, not difficult to work; used in punched, chiselled, moulded, and rubble work." (*J. W. Mellon.*)

In the north-eastern part of the Carlow granite ground the rock comes to the surface in different places; but it is often either a grownan, or too friable for use, and it is always more or less coarse. In addition to the surface-blocks, the following seem to be the places in which the better stones can be quarried:—

Palatine, on the mearing of Wicklow and Carlow. Grey, coarse-grained, regularly jointed. (G. S. M.)

Ballyloo, about two miles northward of Nurney. Regularly jointed; has a tendency to break-up into cuboidal blocks. (G. S. M.)

Graigie na Spiddoge, nearly three miles north-east of Nurney. Coarse-grained; felspathic; well-jointed; easily raised. (G. S. M.)

Nurney. More or less similar to last. In places in this vicinity, as also to the S.W., in the country about a mile and a-half east of Leighlin Bridge, similar stones have been quarried. (G. S. M.)

The "Carlow Stone," which has been so largely sent by canal and road to Dublin, Waterford, Kilkenny, and intermediate places, has been procured from a tract about ten or eleven miles long, and from three to four miles wide, extending from Ballybegs, about seven miles N.E. of Carlow, south-westward to Ballywilliamroe, east of Bagenalstown.

In this area excellent surface-stones have been procured, especially at *Crane*, *Kildranagh*, and *Ballywilliamroe*, respectively, five to eight miles N.E., and two miles E. of Bagenalstown, the blocks vary in magnitude to ten tons and upwards, while some stones have been raised from workings. "In Bagenalstown, granite is the material generally used for cut-stone purposes, the solid stone being close to the town on the east." (*Wilkinson*.)

Ballybegs, about seven miles north-east of Carlow. Grey to yellowish; more or less felspathic; micaceous; some portions liable to discolour with iron. This quarry was formerly very extensively worked. Of it *Wilkinson*, writing in 1845, states: "This is the only quarry in the county sunk to any depth for procuring this stone. The quarry is about 40 feet in depth, and covers an area of about 300 square yards. The stone is procured in large, irregular blocks; the joints running nearly perpendicular, or at an angle of about 15°."

Kildranagh, about six miles north-east of Bagenalstown. Coarse, very felspathic; mica black and grey; lumps of semi-crystalline quartz. (*Wilkinson*.)

Newtown, about three miles east north-east of Bagenalstown. Felspathic; micaceous; some schorl; felspar rather reddish. (*Wilkinson*.)

Kilcurragh, near Bagenalstown. Grey to nearly white; loosely aggregated; felspar white and opaque; quartz; white, mica grey. (*Wilkinson*.)

In places near the margin of the granite, and in the associated schists, are elvans, sometimes so fine as scarcely to be distinguished, in a hand specimen, from a felspathic grit; while others are more granitoid. (*Jukes*.) This variety is fine and very micaceous. It attracted *Wilkinson's* attention, as it appears to have been much used by the early builders, it being more easily worked than the ordinary granite. From him we learn that in the old Wells Church, a mile and a-half south-west of Bagenalstown, it was

worked up with limestone; but it is now much weathered. In Ballymoon Castle, about two miles to the east of that town, it was extensively used. This latter building is very interesting and peculiar. It is about 200 feet square; the walls being about 20 feet high, built in range-courses. Most of the stones selected for outside work have on the outer face a film of quartz, which has kept them until now, as sound as when first used, while any without the film are much disintegrated on the surface. The fine portions of the stone were worked with remarkable smoothness, and used for the splays of openings. Its good qualities for inside work are displayed in the interior of the building, protected from the weather, where they are still quite perfect, while exposed surfaces have weathered away to the depth of about an inch. Wilkinson observes that "the weathering has been most even, showing the equality in the texture of the stone."

[In the veins or courses of granite proceeding from the main intrusion mass, it is not uncommon to find the granite adjoining the joint surfaces, which are more or less parallel to the walls of the courses, coated with a film of quartz. We may here note that, as mentioned below, in the Co. Wexford, in some of the courses there are ribs of veined quartzite; the vein or "grain" (to use the term applied to the similar structure in the granite) being parallel to the walls of the course. In these quartzites (if they may be so called) the perpendicular "grain" is regular; but the horizontal "grain" is not so.]

SCHISTS.

Schists occur in a small tract in the S.W. of the county, in the neighbourhoods of Newtownbarry and Clonegal. They are used for walling purposes.

KILKENNY.

GRANITES.

This rock occurs, as outlying exposures, S.W. and S. of Inistioge, in the parish of Jerpointchurch, and to the north-west of Tullagher, also in four small patches eastward of that town, south of Graiguenamanagh, in Brandon, and that neighbourhood, where it is the S.W. termination of the Leinster range; and adjoining the Co. Carlow, between Graiguenamanagh and Goresbridge. It is described by Jukes as

“ for a granite a very perishable stone, often decomposing on the ground to a considerable depth.” In the vicinity of the granite are elvan veins differing from it “ partly in the rareness or absence of mica, and partly in the fineness of grain ; so that in a hand specimen the rock might be mistaken at first sight for one of the fine-grained *Ordovician* grits. (G. S. M.) These are similar to the Co. Carlow elvans. No large quarry has been opened ; the stone, when required, being procured from the large granite erratics. These blocks are very numerous near Mount Loftus, adjoining the River Barrow. Many of them are roughly squared ; as, some years ago, the Messrs. White, of Waterford, contemplated building a dry-dock there ; and about 600 tons of squared blocks were brought by boat from this place. As the design for the dock was not carried out, the rest of the blocks were left here ; while those boated to Waterford were sold for foundations, &c. Granite either from this county or Carlow, has been used in the following structures in Waterford :—For the fronting of the Savings Bank, new Courthouse, and new Bank of Ireland, along with limestone ; new Methodist Church ; Post Office Buildings, and the Clock Tower on the quay. (*J. Budd.*)

WHINSTONES, &c.

Whinstones occur as intrudes in the granite area, between four and five miles S.W. of Inistioge. *Euryte* (?) associated with *Tuff* is found at Ballyneale, three miles N.W. of New Ross. These are used only for road metal and farm purposes.

Margining the various small exposures and the large tract of granite, the *Ordovicians* are more or less altered into *schists*, which are used for local walling purposes

CO WEXFORD

GRANITE ROCKS.

In the south-eastern part of the county, margining the sea, and in the Saltee Islands, there are granites and granitose gneiss of *post-Cambrian* and *pre-Ordovician* age (*Arenig*). The granites are partly intrusive, and partly of metamorphic origin, the latter

graduating through schists into unaltered Cambrian. In the metamorphosed Cambrians are various metamorphosed volcanic rocks, with their associated tuffs and agglomerates. The latter are of very little value, as they rise in unsightly blocks, not well suited for sea-walls.

At *Carnsore* there is a vein of very superior bright red granite. It is regularly jointed, and capable of being raised in naturally square blocks of large scantlings, suitable for long and heavy bearings. It plugs and dresses well, and takes a good polish, as was exemplified in the specimens exhibited in the Dublin Exhibition of 1853. The vein ought to be cheaply and easily worked, while the stones could be shipped from Ballygeary. A short time since a company was formed to work this stone; but it was not allowed to proceed, as the agent of the property considered that the unavoidable accompaniments of the working of a quarry would be detrimental to the property. In the same neighbourhood there is a handsome, light-coloured, porphyritic granite.

In the neighbouring *Saltee Islands* there are grey and light salmon-coloured granites, which might be made use of with advantage, if there were facilities for working them in the neighbourhood of Carnsore.

In the same district, and near Greenore, there are green granites (Hornblende rock).

Granite Intrudes at Glenbrien, Ballynamuddagh, &c.—These occur in the county S.E. of Enniscorthy. On the old geological map of this district a considerable area of granite is here shown; but after careful examination it appears more probable that this really consists only of four or five small intrudes, with accompanying veins or dykes in the associated rocks, especially to the eastward.

Near *Ballaghkeen* there is elvan, graduating into granite; the latter in part growan. Near Ballymote and Corbally Bridge there is granite and elvan, the latter nearly white. Granite and elvan have also been quarried at *Ballynamuddagh* and *Glenbrien*. At the former the rock is fine and even-grained; irregular veins and other intrudes extend from it into the associated iron-masked schist, which is locally called "spawl stone." These rocks can be traced westward, apparently joining the localities at and near *Vinegar Hill*, and other places in the *Enniscorthy* neighbourhood,

thus suggesting that the granite and elvan are of a later age than the Ordovician.

A long, narrow breadth of the S.E. marginal part of the great Leinster granite exposure lies within this portion of the Co. Wexford. In the schists outside of the margin, and running somewhat parallel thereto, there are a few courses of generally finer and more compact granite. In these there is a structure rudely parallel to their walls, giving them a bedded aspect; while in some of them, conforming to this simulated bedding, there are thick courses of quartz-rock, in some places of blackish or smoky colour. These quartz-rocks seem to be allied to those near Hacketstown, Co. Carlow.

All over the granite-ground, as also on the margining mica-schist, numerous surface-blocks abound, they being very conspicuous in the valley of the River Clody, to the N.E. of the summit of Mount Leinster. On this account no quarry has been opened in the main mass of the granite; but the courses in the schists are quarried at several places, to supply materials for walling and for road-mending; while for cut-stone purposes the large loose granite blocks are preferred. At Gorey the Norman columns and other dressed work of the cathedral were formed from them. The rock is generally more or less even-grained, similar to the Co. Carlow stone, except on the slopes of Blackstairs and White Mountains, where it is porphyritic with white crystals of orthoclase. This bright grey porphyritic rock would be very effective for ornamental purposes; but we could not learn that it has ever been so utilized.

[The inhabitants of the country near Blackstairs and White Mountains seem to be generally stonecutters and smiths, each having a little smithy attached to his cabin to repair and sharpen his tools. Formerly these people did a good trade, partly in cut-stone, but principally in gate-posts, farm-rollers, cider-presses, and paving-setts; large quantities of the last used to be sent to Waterford, New Ross, Wexford, Enniscorthy, and other small towns.]

WHINSTONES, EURYTES, FELSTONES, TUFFS, ELVANS (Root Rocks, or Laccolites).

Crossing the Co. Wexford obliquely in a N.E. and S.W. direction, and extending into the Co. Waterford, there are more or

less continuous massive sheets of whinstones, eurytes, felstones, and tuffs interbedded in the *Ordovicians*; while in the country immediately to the S.E. are dykes and other intrudes connected with them. Most of the intruded rocks in the zone of these volcanic rocks are more or less similar to the bedded masses; but one variety is very peculiar, having all the characters of a tuff, or agglomerate, and containing limestone concretions, but behaving in mass like a normal intrusion. These are conspicuous in the country S.E. of Ferns, and also to the N.E. of Adamstown; but their intrusive character can be best studied in the coast section between Kilmichael Point and Courtown Harbour. (*Ballymoney Section*.) The intrudes seen to the S.E. of the sheets are masses of elvan, apparently the laccolites or roots of the interbedded rocks. They are very fine-grained, and the mica is in exceedingly small scales, and seems to be sometimes replaced by minute crystals of hornblende. None of these rocks, whether bedded or intruded, seem to be in request, except in a few places, and only for mere local purposes. However, when the railways were being made they were used for building walls and bridges; when it was found that some of the green calcareous tuffs were very suitable for cut-stone purposes. That they are durable is proved by the state of preservation of the beautiful doorway of Clone Church, near Ferns.

[In describing the limestones of this county (page 195, *supra*) and the partly similar calcareous tuff in Limerick (page 183, *supra*), it was suggested that this class of stone is "not durable." But this may not be universally applicable. The stones after some time become discoloured, and seem to be decaying: this is due to the leaching out of the iron, which, however, seems to give them new life, and some at least of them will regain their green colour and acquire a permanent condition.]

Clone, a mile south-west of Ferns. Bright green; calcareous; fine; works easily; thin-bedded, and capable of being raised in stones of fair scantling. Used in the new church at Clone, in both walling and dressing. The suitability of this stone for minute and beautiful work, as also its durability, is well exhibited in the old church at Clone, especially in the doorway. In the old castle of Ferns, and in the early ecclesiastical buildings there, a similar stone was used.

Between Enniscorthy and Ferns the D. W. W. Railway has made excavations in calcareous tuff, and used the rock for cut-stone purposes, and for rubble work in the bridge and walls.

Between *Adamstown* on the S.W., and the parish of *Clone* on the N.E., are calcareous tuffs, some of which seem to be rich enough to burn into lime, while all, if ground up, ought to be good fertilizers, especially for boggy land.

Dunganstown, four miles S.S.W. of New Ross. Green, white, speckled granitone; a very nice-looking stone, like some of those formerly quarried in Egypt.

Localities of varieties of hornblende rock of good appearance.

Corcannon, S. W. of Arklow. Very fine-grained; olive green; slightly granitoid.

Ballybrennan, about three miles S.W. of Enniscorthy. Nice-looking; light green; mottled. *Aughnally* and *Cresfoge*, southward of Enniscorthy. Pale, greenish-grey and yellowish-greenish; nice-looking; finely mottled.

Palace, east north-east of New Ross. A handsome green-and-white granitoid rock.

Ballaghboola, near New Ross. Greenish, white, speckled granitoid rock.

North of *Clogh*. Mottled green, fine-grained, slightly granitoid.

Crann Mountain and *Ballythomas*, N.E. of Wicklow Gap, at the north of the country. Nice-looking, greenish stones; some mottled in veins.

QUARTZ-ROCKS AND SCHISTS.

The Quartz-rocks are almost entirely confined to the *Cambrians*; although they occur sometimes in the adjoining *Ordovicians*. In the neighbourhood of Wexford they have a horizontal structure, and can be raised in sizes suitable for walling. They have been extensively used in the buildings in the town, and for road metal; elsewhere they have been very little quarried.

The *Ordovicians* margining the granite in the north-west part of this county, as also a wide belt of the rocks of this formation on the south, and margining the *Cambrians*, have been altered into schists. The *Cambrians*, south-east of the trough of Carboniferous limestone that extends from Wexford Harbour, south-westward, to Duncormick, are also altered, sometimes to a very great extent, being changed into gneiss, or even granite, while those to the

N.N.W. and W. of this trough are not as much changed; in some places, such as at Cahore, to the N.E., and at Bannow, to the S.W., they contain fossils.

The schists belonging to both geological groups usually split into flat-bedded stones, suitable for walling; they are, however, very little used in the south-eastern part of the county, as the inhabitants, especially those of "The Baronies" (Forth and Bargo) prefer clay for the house-walls and fences. In the N.W. part of the county, however, they are slightly more in demand.

CO. WATERFORD.

The older rocks in this county, *Ordovicians*, are the south-westward continuation of those in Wexford, and like them belong to the middle group (*Ballymoney Series*). These are interbedded and intruded whinstones, eurytes, felstones, tuffs, &c. These are so similar in character to those of Co. Wexford that the reader may be referred to the descriptions just given of the latter.

It may, however, be mentioned that in places very small portions are changed into serpentines and steatytes; but none of them seem to be of sufficient extent to be commercially valuable. These rocks occur principally in the S. W. of the county between the River Suir and the sea; but there are also a few to be found west of Portlaw. In the *Silurians*, west of the Reeks of Glenpatrick, there are some dykes of whinstone; but none of these rocks have been specially sought after; although some of the fine green tuffs might be suitable for cut-stone purposes.

WATERFORD.—Model School, *Bagenalstown granite*; Court-house and Asylum, *Carlow granite*. The Savings Bank, new Court-house, new Bank of Ireland, new Methodist Church, Post-office buildings, and the clock tower on the quay, granite from either *Kilkenny* (Mt. Loftus) or *Bagenalstown*, has been more or less used for the facings of these buildings. Mount Congreve, Whitefield, &c., *Carlow granite* used for porticos, &c.

[The English when building the walls and the fortifications of Waterford and extending them, which they did two or three times afterwards, "requisitioned" the neighbouring farmers for so many loads of stone each. Those persons brought what was nearest to hand, which accounts for the varying composite character of the building in some of those erections. The mortar, however, that was used was of excellent quality. (*J. Budd.*)]

MUNSTER, OR SOUTH-WEST IRELAND.

[Clare, Tipperary, Limerick, Kerry, and Cork. Although Waterford is also in Munster, as its rocks are so intimately connected with those of Wexford and Wicklow, it has been described with the S.E. Territory.]

Chronological Account.

The groups in this area are Ordovicians, Llandovery or May Hill Sandstone, Silurian, Devonian or Lower Old Red Sandstone, and Carboniferous.

[In Cork and Kerry, as already explained, there are types of strata not found elsewhere. The Glengariff Grits and Dingle Beds are a peculiar type of the Silurian, although somewhat similar rocks (*Mweelrea Beds*) occur in Cos. Mayo and Galway, and others in Fermanagh and Tyrone (*Fintona Beds*); while the Yellow Sandstone and Carboniferous Slate are different from any Carboniferous rocks elsewhere in Ireland.]

In the Anascaul beds (ORDOVICIANS) there are to the north, and also some distance south of Anascaul, felspathic tuffs.

In the Ferriter's Cove series (SILURIANS) Dingle promontory, at Swerwick Harbour, Ferriter's Cove, north and south of Clogher Head, and in Inisvickillaun, there are whinstones, felstones, and numerous beds of tuff; in Beginish and Young's Island, also, there are tuffs.

In the Glengariff Grits (SILURIANS) there are intrudes and apparently interstratified sheets of euryte and whinstone with, in places, their associated agglomerates and other tuffs.

[The Glengariff grit eurytes are geologically both interesting and important, as they are characteristic of these Silurians. They occur not only here but in the Silurians of North Galway and South Mayo, in those of Fermanagh and Tyrone, and in the Silurian conglomerate at Cushendun, Co. Antrim.]

The "Lower Old Red Sandstone" of the Geological Survey maps (under Jukes) of Kerry and Cork is the representative of the *Devonian, or the passage-beds between the Silurian and the Carboniferous*. As their upper limits are not exactly defined, it is possible that some of the exotic rocks supposed to be in the Silurian may possibly be more properly in them. Elsewhere there are intrudes and apparently interbedded sheets of whinstone. In places at the base of the LOWER CARBONIFEROUS SANDSTONE there is a peculiar

quartzite, while higher up are some intrudes or interbedded eurytes. But the greatest development of the exotic rocks are intruded and interbedded whinstones, eurytes, and felstones (?), with associated agglomerates and other tuffs at the junction of the *CALP* and *FENESTELLA LIMESTONES*, a second being higher up, partly below, and possibly also in the *Coal-Measures*, as hereinafter mentioned. Below the lower zone there are isolated intrudes or protrudes, usually elvans, but in some places felstones, whinstones, or even agglomerates.

There seems to be no evidence of the later exotic rocks in this territory, except, perhaps, some of the dykes in the *CARBONIFEROUS SLATE*, Co. Cork, which may possibly be of tertiary age.

Territorial Description.

CLARE, TIPPERARY, AND LIMERICK.

In places at the base of the *Lower Carboniferous Sandstone*, especially in the neighbourhood of Lough Graney, there is a peculiar quartz-rock, the basal rock of the formation. This rock, when well developed, is very pure, and seems to have been deposited from solution on the floor of the Carboniferous sea. This, in places, is replaced by a peculiar limestone. This quartz-rock has not been in any way utilized; yet it seems capable of being used as a substitute for flint in the glass and china trades.

In the *Carboniferous Limestone* of Clare there is a tuff at Meelick, a few miles north of the Shannon, while in Co. Limerick the exotic rocks are largely developed. In part surrounding and margining the *Ballybrood Coal-Measures* there are whinstones with their associated tuffs; and extending from them into the *Coal-measures* is a long whinstone mass, which may possibly have been intruded into the latter; but more probably it is a protrude, that is, a high rib, against and on which the *Coal-Measures* accumulated.

Outside, forming an oval ring, at the juncture of the *Calp* and the *Fenestella Limestone*, there are interbedded whinstones, eurytes felstones (?), and tuffs, with, in places, intrudes partly allied to elvan. The tuffs range from a fine rock, often calcareous, to conglomerates and massive irregular agglomerates.

Outside this oval, in places, to the south, are intrudes of elvan, with, near Castle Farm, a peculiar felstone, having, in places, an aspect like trachyte; while to the northward, at Maddyboy, there is a boss of elvan. In the north part of the county there are small detached exposures of tuff, euryte, and whinstone, to the south of Castleconnel, at Knockbrack, Limerick, Carrigogunnel, Kilpeacon, Rosborough, and Cahernarry, with smaller ones to the west, near Shanagolden.

In Knockfeerna and Ballinleeny there seem to be either intrudes, or protrudes of a rock that is apparently euryte (*Daubuisson*), around which the sandstones accumulated. They are quarried for rough walling and road metal. In the eastward part of the county, in the Bilboa River, near Doon, there are felstone dykes.

None of these rocks have been much utilized. In the neighbourhood of Limerick there are some considerable quarries in the tuffs, which are used for road metal and general walling purposes. For the latter they are eminently suitable, as they rise in flat-bedded, well-shaped blocks. In the new railway station, and in some other buildings in Limerick, they were used for quoins and facings. Generally throughout the country in which the exotic rocks occur they are only quarried for local purposes, principally for road metal; but for the latter purpose many of the quarries are in the tuffose rocks or limestone, and not in the more durable whinstone. Many of the elvans rise in ill-shaped blocks; but this is not so in the quarry near Caherconlish, where nice stones of fair scantling can be procured.

Small pieces of the following rocks have been cut and polished:—

Killeena, Co. Limerick. Red porphyry, with salmon-coloured and blackish spots; cuts and polishes easily, but shows verts.

Knockroe, Co. Limerick, S.E. end of boss. Very similar to last in colour; cuts and polishes easily, but shows verts.

Knockroe, centre of boss. A handsome porphyry; purplish, with red and white spots; cuts and polishes well.

Knockroe, at outside of boss. Striped purplish; cuts and polishes well.

Long Stone, Co. Tipperary. Buff, porphyritic; cuts and polishes well.

Cromwell's Hill, Co. Limerick. Shaded yellowish-brown; cuts well, polishes fairly, but shows minute vesiculars.

Killeely Hill, N.W. of Priest's House, Co. Limerick. Yellowish-brown; slightly spotted; cuts and polishes well.

The following all out and polish well; they are of various shades of grey, but none of them give handsome stones:—*Killeely*, *Castlefarn*, *Knockdirk*, *Ballynard*, and *Coolnapisha*; all in Co. Limerick. The last is porphyritic; and in places the stone is changing into ophyte. Probably better stone might be procured in the vicinity.

Some of the conglomeritic tuffs, especially those near Lough Gur, can be easily raised in squarish blocks of large scantlings. These have not been much utilized in modern times; but some of the prehistoric forts, or cahers, were, in a great measure, built of them; the wall of the caher, or rath, being composed of megalithic blocks, placed on edge or end, and banked on the outer face with earth. The blocks were rudely fitted together; the interstices being filled in with smaller pieces.

[In treating on the MARBLES and LIMESTONES we mentioned the *Calcareous tuffs* of Limerick, and raised the question as to their durability. For further information on this subject see Wexford.]

In places the whinstones and eurytes of the Co. Limerick, appear suitable for paving-sets; it may therefore be suggested that an export trade from the port might be established; the stones being sent to England in the return colliers and other ships, instead of the ballast which they now so often carry on their return journeys. Some of the more calcareous tuff, also, seems to be capable of being utilized in the manufacture of hydraulic cements. Before, however, either of these industries were commenced, the likelihood of success and ultimate profit should first be thoroughly investigated.

CORK AND KERRY.

In the Dingle promontory, Co. Kerry, the tuffs in the Anascaul beds (*Ordovician*) and the tuffs, felstones (?), and whinstones in the Ferriter's Cove beds (*Silurian*) are not put to any special use, except for local farm purposes, as better stones can easily be procured. Some of the tuffs, however, rise in nice flat-bedded stones, suitable for walling.

In the Glengarriff Grits (*Silurian*) there are in the islands of Valentia and Beginish, as also in the adjoining mainland (*Ballycarbery*), whinstones, felstones, and tuffs (conglomerate). These appear along the lines of stratification for the most part, and on account of the associated tuffs might be considered as interbedded; in places, however, they are evidently, in part, intrusive; more especially the felstones, as these have baked all the rocks in contact with them. These rocks do not seem to be put to any use; yet some of the whinstones might be capable of being wrought into good paying-setts, kerbing, &c., while freight in return ships from the western coast ought to be very low. Quarries could easily be opened on Valentia, or perhaps more easily on Beginish, or the mainland. The small dykes of whinstone, observed elsewhere, it is unnecessary to describe.

In the Killarney district adjoining the Horses' Glen (*Mangerton*), and in Glenflesk, there is a considerable exposure of euryte and its associated tuffs. These have been considered to be more or less inter-stratified with the associated *Silurians*; but this may be a misconception; the mass is perhaps the remains of a volcanic cone that protrudes into the associated rocks, which were deposited around and over it. The apparent continuation of the tuff into the associated grits and shales seems to be due to detritus from the tuff, deposited as tuffoid rocks from time to time, they thus having a tuff composition, but being of an age long subsequent to that of the accumulation of the volcanic cone.

These rocks have not been utilized, except for local purposes; yet some of them, especially in Glenflesk, are handsomely spotted, and porphyritic, in shades of red and purple, and ought to be valuable, if polished for ornamental purposes.

Near Lough Guitane there is a rock mapped by Du Noyer as felstone tuff. It is light-green in places, porphyritic, compact, can be raised in large blocks; should cut and polish well.

In the Bearhaven promontory, Co. Cork, in the *Deronians* of Cod's Head, Dursey Island, Crow Head Promontory, Horn Point, and between Kilkinnikin and Dunboy, there are whinstones, some being in dykes or other intrudes, while some seem to be interbedded. The dykes of Crow Head Promontory are distinct from the others, and may possibly be of TERTIARY AGE. All these rocks are more or less inaccessible, and do not seem to have been utilized.

In the *Carboniferous Slate* of the south and west parts of Bear Island, and thence eastward on the mainland along the north shore of Bantry Bay to White Ball and Black Ball Heads, there are numerous intrudes, and in places, apparently interbedded sheets of felstones and tuffs, with later intrudes of whinstones. To the northward there are felstones and tuffs, which seem for the most part, interbedded; higher up are some apparently bedded whinstones, while more southward, both on the island and mainland, are evident intrudes of whinstone; some of these are perpendicular dykes that overflowed, forming a cake on the present surface of the ground. This may possibly indicate that these whinstones are much newer than the other rocks of the country, and perhaps of *Triassic* or even *Tertiary* age.

In the *Carboniferous Slate*, near Black Ball Head, there is a small mass of agglomerate connected downwards with dykes of agglomerate, which come up through the Devonian and Yellow Sandstone; while extending eastward from the mass are felstones and whinstones, which appear to be interbedded with the associated grits and shales.

The exotic rocks of this area do not seem to be utilized, except very sparingly, although some appear suitable for paving-sets, kerbs, &c.

In the *Glengarriff grits*, about five miles S.S.W. of Mallow, there is a boss of agglomerate; while in the *Carboniferous limestone*, three miles east of Kanturk, there is another larger one. The latter appears to be on about the same geological horizon as the before-mentioned zone in the Co. Limerick.

NORTH-WEST AND NORTH IRELAND.

[Galway, Mayo, Sligo, Roscommon, and Leitrim, in CONNAUGHT; and Fermanagh, Donegal, Tyrone, Londonderry, and Antrim, in ULSTER.]

Chronological Account.

It appears evident that at one time the greater part of this territory was a continuous tract of more or less metamorphic and granitic rocks; but it is now partially covered by masses of later rock, which, after deposition, have suffered considerable denu-

dition. It is possible that these newer rocks may have extended, at one time, over the whole area; but of this there is no satisfactory evidence, except in relation to the Carboniferous, outliers of which are found everywhere throughout the area, the most important being small patches of the basal conglomerate on some of the high hills in Galway, Mayo, and Donegal.

The exotic and allied rocks to be described range from Cambrian to Eocene (?) in age, and vary in composition from basalt to granitic, and schistose rocks.

CAMBRIAN and ARENIG Granites, Elvans, Whinstones, Eurytes, Felstones, Quartz-Rocks, and Tuffs.—All these, in Connaught, are more or less altered into different varieties of hornblende-rock, ophyte, schist, gneiss, and granite; but in some places in Ulster they are very little, if at all, changed.

ORDOVICIAN and LLANDOVERY Granites, Elvans, Whinstones, Eurytes, Felstones, Quartz-Rocks (?) and Tuffs.—In Connaught most of these rocks are altered similarly to those of Cambrian age; but in Ulster many are unaltered; the whinstones are generally diabase and dioryte or allied rocks. Some of the quartz-rocks may possibly belong to this age.

Towards the end of the Ordovician, or during the Llandovery age, there occurred the most active metamorphism of which we have evidence in Ireland. In this territory it altered, in Galway, Mayo, Roscommon, and Sligo all the Cambrian, Arenig, and nearly all the Ordovician rocks. It also altered the similar rocks in Donegal, Londonderry, Tyrone, and Antrim; but here the action was not as universal, the Ordovicians and Arenigs (?) partly escaping.

Connected with this period of metamorphism was the production of the metamorphic granites of Galway, Mayo, Roscommon, Sligo, and Donegal, and the older intrusive granites of the same counties, with their accompanying elvans and other intrusive rocks.

[Some of the intrusive granite of Mayo, namely, that at Termon, Blacksod Bay, may have been pre-Ordovician, and therefore older than the others. The foliated granite of the Castlebar and Lough Conn district was foliated at the same time as the associated metamorphic rocks; it therefore must also be older, except that the foliation belonged to a second and more recent period of metamorphism, to be mentioned presently.]

SILURIAN and DEVONIAN Granites, Elvans, Whinstones, Eurytes, Felstones, Quartz-Rocks, and Tuffs.—In Mayo some of the

Silurian rocks are altered; in the other counties they are not so. In places the basal euryte of the *Mweelrea beds*, Co. Mayo, is replaced by quartz-rock of a nearly similar nature to that mentioned above, as occurring at the base of the Carboniferous rocks in Munster.

In north-west Galway some of the bedded eurytes can be traced downwards by dykes to bosses of elvan and granite, in the Arenig rocks of Lugnanoon, south of the Kylemore valley.

CARBONIFEROUS Granites(?) Elvans(?) Whinstones(?) Eurytes(?) and Felstones(?).—It cannot be shown that any of the exotic rocks are certainly of Carboniferous age. In Mayo, to the S.W. of Croagh Patrick, are the *Corvockbrack granites*, coming up through, and altering, the Silurian rocks; they may, possibly, be of Carboniferous age; but one kind of elvan, that seems to be an adjunct of it, graduates into a uraltic gabbro, which may render this supposition questionable.

In West Galway, Mayo, Sligo, and Donegal, there are melaphyres, eurytes, and felstones, newer than the Silurians. These are very like those elsewhere that are known to be of Carboniferous age; but in West Galway, associated with them, there are dolerytes identical with those of Antrim. However, there are apparently, hereabouts, two systems of whinstone dykes of different periods.

[In connexion with the Corvockbrack granite is a tract of metamorphic Silurians. The exact time during which the metamorphism took place is uncertain; it is possible that it took place near the end of the Silurian or in the Devonian time, and that the interbedded eurytes in the Fintona beds (Cos. Fermanagh and Tyrone) are products of this metamorphism; but these rocks are similar to, if not identical with, the Bundorragha eurytes at the base of the *Mweelrea beds* (Co. Mayo), and consequently they are probably older than this granite. Furthermore, the granite is very similar to that elsewhere, which is supposed to be of Carboniferous age; and, if this is allowed, the metamorphic action must have taken place during the Carboniferous period. The above-mentioned Lugnanoon granite and elvan, south of the Kylemore Valley, are positively the root rocks of the Silurian eurytes, and are quite different from, and, as I believe, much older than, the Corvockbrack granite. If this is correct, the latter must be post-Silurian.]

TRIASSIC Granites (?) Elvans (?) Whinstones (?) Eurytes (?) and Felstones (?)—Doleryte occurs associated with the Triassic in Co. Tyrone. In North Mayo there are post-Carboniferous exotic rocks, some of which are probably of Triassic age.

Eocene Elvans, Whinstones, and Trachites.—In Antrim and

the adjoining parts of Londonderry are the great sheets of intrusive rocks of Eocene age, which have their granitic roots, or elvans, near Portrush, at Tardree, and other places. The elvans near Portrush are associated with metamorphosed *Lias*.

Territorial Description.

In *North-West and North Ireland*, including portions of Galway, Mayo, Sligo, Roscommon, Leitrim, Fermanagh, Donegal, Tyrone, Londonderry, and Antrim, there was at one time, as already mentioned, one large tract occupied by metamorphic and granitic rocks; the rocks now altered being the equivalent of the Llandovery (P), Ordovician, Arenig, and Cambrian, the metamorphism having taken place in or towards the end of the Llandovery age. All these strata having been contorted, upheaved, metamorphosed, and denuded before the overlying Silurian rocks were deposited on them, the patches of the later rocks that now partly separate the different tracks having had no special influence on the extent of the original area.

The areas of exposure of these metamorphic rocks may be conveniently grouped, for the purpose of description, into four districts, as follows:—*Galway and West Mayo; East Mayo, Sligo, Roscommon and Leitrim; Donegal, Tyrone, Londonderry, and Fermanagh; and Antrim.*

GALWAY AND WEST MAYO.

Galway is the foremost county of Ireland as to the variety in composition and colour of its granitic rocks, these varying from fine and nearly compact to largely porphyritic, and being of many colours, white, green, shades of red, greenish, yellowish, blackish, &c.; some being mottled and others clouded; while associated with them are variously-coloured elvans, porphyries, and felstones. The extent of the tract is about equal to that of Donegal, and about a third of the size of the Leinster granite area. To the southward the marginal granites have a bedded appearance; while to the north and north-east the foliated porphyritic granite (*granitic gneiss*) graduates through gneiss into schist. Coming up through the porphyritic oligoclastic granite, but more frequently in the adjoining gneiss and schist, are dykes and masses of the ordinary grey ortho-

clasic granite, and the varieties of oligoclasic granite so varied in texture, colour, and beauty.

The prevailing colour of the mass of the porphyritic *oligoclasic granite* is mottled pinkish, with smaller white and greenish crystals of felspar, and larger crystals, often twins, of flesh-coloured felspar, which give the rock its porphyritic character. Conspicuous accessories in this rock are titanite (*sphene*) and blackish hornblende. Towards the west of the county there is a less coarsely and more evenly crystalline oligoclasic granite (*Omev type*), in which titanite and hornblende rarely occur. In places, coming up through these oligoclasic granites, the gneiss and the schist, there are the ordinary light-grey or whiteish *Orthoclasic granites*, sometimes forming tracts, as in the neighbourhood of Oughterard.

In the north-west of the Co. Galway, near Kylemore, at Lughnagoon, there is a mass of much newer oligoclasic granite, graduating into elvan, it being of the same age as the sheets of euryte (*Bundorragha euryte*), in the Silurian rocks (*Muceetrea and Slieve Partry beds*).

[At *Lughnagoon, Omev Island, Illaun M'Dara*, and neighbourhood, very long blocks of large scantling might be raised; those in *Illaun M'Dara* and in *Omev Island* being very easily procured.

The boulders found on the Galway tract of granite extending from Lough Corrib westward to Kilkieran Bay are of very great magnitude; so that blocks of all probably required sizes could be obtained from them. Some of these boulders have undoubtedly split up since being left in their present position; but the majority of them, some of vast size, are as sound now as when the ice deposited them.]

GALWAY QUARRIES. As has just been mentioned, the granites, elvans and porphyries are greatly varied in texture, colour, and beauty. These have been brought lately into the market by the Messrs Millar, of the "Galway Marble and Granite Works," who are prepared to supply obelisks, columns, dies 3 to 4 feet square, caps, bases, headstones, and all kinds of monumental and other cut-stone and polished work. At present they can raise blocks 10 feet long by 2 to 3 feet square, and slabs from an inch upward in thickness, 9 feet long and 3 feet wide. The principal quarries now being worked are:—

No. 1, *St. Helen's, Taylor's Hill*.—Fine-grained; red, clouded with yellow, maculated with black and a little white; polishes well; can be got in blocks from 5 to 7 feet long; a very serviceable stone

No. 2, *Shantallow*.—Fine-grained; red; maculated white, with a little black; polishes well; blocks up to 5 and 7 feet long; a very serviceable stone.

No. 3, *Ballagh*, near Bush Park.—Porphyritic; red and greenish yellow, with large flesh-coloured crystals; polishes well; can be raised in long and very large blocks; a handsome stone. Here was obtained the pedestal for Dargan's monument, *Leinster Lawn*, Dublin.

No. 4, *Letteragh*, north of Rahoan House.—Lighter in colour than Ballagh stone (No. 3); coarser in grain than the St. Helen's and Shantallow; clouded and mottled greenish and purplish, with large bright-red isolated crystals and blebs of quartz; allied to an *elvan*; can square 4' 6" \times 2' 6" \times 2'; some blocks over 6 feet long. This has been only recently opened, and it is expected to improve in depth.

No. 5, *Shantallow* (again).—Chocolate-colour, with large bright-red crystals of orthoclase and blebs of quartz. A *granitone*, or basal *elvan*, seems to be allied to the *Bundorragha euryte*.

Messrs Millar's quarries, except No. 3, are in veins of granite or *elvan*, in which blocks suitable for general purposes, but not of very great size, are procurable; the granite No. 3, however, not only in the neighbourhood of Galway, as already mentioned, but in the whole county forming the north-side of Galway Bay and in Omev Island, can afford blocks as large as it is usually practicable to work. Some of the boulders on that tract that have stood the effects of weathering, since the glacial period, being as large as some of the mediæval castles (see G. S. M. sheets, 104, 105, &c.). The vein-granites, however, that are being worked by the Millar's are of sizes fit for all ordinary work, they being specially suitable for inside decoration; the diversity in colour and texture being most effective, especially if used in slab-work, such as dados and the like.

The uncoursed rubble used in Galway prison was procured from one of the *elvans* in Shantallow; very durable, but too hard for chisel-work. (*R. Cochrane.*)

Good building-stones of any scantling are procurable nearly everywhere in the granite region, at the surface or in blocks; consequently no large quarries have been opened, these easily procurable stones having been sufficient to meet local requirements; at

the same time there are facilities for working a quarry for an export trade in various places where there is water-power at hand, and accommodation for easy and cheap shipment.

In different places in the vicinity of Galway, north-east of Barna House, and elsewhere in the tract north of Galway Bay, felsite-rock (*felsitic granite*) and felsites have been recorded (G. S. M.). All these rocks are more or less similar to the granulyte at present in use in the glass trade (*ante*, Introduction, page 401). *Leptynite*, or hornstone, and very pure felstones occur in places in the neighbourhood of Galway, which seem capable of being manufactured into kaolin, while especial attention may be directed to the numerous compact pure felstone dykes in the country immediately south-west of Roundstone, all of which might be similarly used; some of course being more pure than others.

In Western Mayo, at *Corcockbrack* and *Cregganbaun*, to the south-east of Louisburgh, in the *Silurians*, there is a considerable intrude and veins of granites and elvans; white, shaded-white, various shades of grey, salmon-colour, and light-pink; all being capable of a good polish, and some would be very effective when polished; they rise in fair-sized well-shaped blocks. The locality, however, is very inaccessible; the roads to it being of the worst description of mountain paths; it also wants a seaport.

TERMON HILL, at the south extremity of the Mullet, and north of the entrance into Black Sod Bay, is a mass of granite. This has been quarried at the coast in the vicinity of Termon at Fishery-quay. The quarries have lately been taken by THE MAYO GRANITE COMPANY, who are now preparing to supply, in polished work, columns with plinths and moulded bases, pilasters, steps, &c.; and, in dressed work, kerbings, crossings, paving-setts, quoins, sills, and any other required stones; colours of silvery-grey, salmon, and red shades. In the *Beaufort*, or *S. W. Quarry*, the stones are silvery-grey and pink; in the *Upper Quarry*, grey and red; and in the *Lower Quarry*, pink and salmon-colour. The stones that have been worked are very even-grained, the felspar and quartz predominating, while the mica is in small scales. Mr. Davies writes of this stone, "The grains of quartz, felspar, and mica are fine, and so well-cemented and compacted together that the stone is capable of a very high polish, while they are sufficiently large and distinct to afford a pleasing variety of colour." (*W. Davies*.) The rocks are

traversed by two sets of parallel joints, perpendicular to one another ; so that the stone is cut up into rectangular blocks of various widths, and lengths up to twenty-five feet or more. As the soles or nearly horizontal joints and the upright joints are at distances apart, from six inches to three feet, and in some places to six, nine, or more feet, there is every facility for raising, with wedge and windlass, ready squared blocks of any scantling, and suitable for any kind of work from setts and flagging to huge monoliths. Mr. Reilly, the superintendent, states that if required he could raise a block fifty feet in length and nine or ten feet or more in the square. "About forty years ago the stone was used by the Board of Works in building Termon and Belmullet piers, and also the canal bridge at the latter place, and now it appears to be of excellent quality, and shows no traces of weathering." (*P. J. Lynam.*)

At Annagh Head, also, near Erris Head, are handsome, clouded, and streaked variegated felspathic rocks (*Felsitic granite*), capable of being raised in large blocks. Specimens procured here were found to cut and polish easily and well, with very good results "The rock is red, and pink in colour, massively crystalline and foliated ; it has all the appearance of being very well suited for the manufacture of kaolin, or porcelain clay." (*A. M'Henry.*) Of a polished hard specimen, Mr. Sibthorpe states "it has all the beauties of a limestone and the hardness of a granite."

[These rocks M'Henry considers to be Pre-Cambrian ; they and the associated gneiss and schists are in aspect very similar to the *Primary gneiss of Sutherlandshire.*]

In the Owenmore Valley, west of Bangor, there is a small tract of gneissose granite ; the rock, however, is so much jointed that it is not suitable for cut-stone purposes.

ELVANS, 'FELSTONES, EURYTES, WHINSTONES, QUARTZITES, SCHISTS.

The *elvans* in Galway and Mayo are very varied in age, colour, and composition, graduating into felstones ; and the basic *elvans* (*granitone*) into eurytes and whinstones. They occur more frequently in or adjoining the granite area ; but they are not uncommon in the schist of the western and north-western parts of the county Galway. Some of them, especially near the town of Galway, as already mentioned, are of great beauty and variety.

In the west of the county, near Clifden, and thereabouts, there are *granitones*, probably of Silurian age. These are very suitable for harbour and cut-stone purposes, as they rise in squarish blocks of fair scantling, tool, and plug easily, and are apparently durable; although they do not retain their light-greenish colour.

At *Waterloo Bridge*, a little eastward of Clifden, a quarry was opened when the quay at that place was being built; and very good stones, suitable for cut-stone purposes, were procured. This rock is somewhat allied to granitone. It cuts and polishes well; it is of a mottled leek-green colour.

Elsewhere no quarries have been opened; except small ones for quite local use. The *granitones*, allied to hornblende-rock, and possibly suitable for ornamental purposes, are given on page 446.

The *elvans*, in connexion with the Corvockbrack granite, have already been mentioned. One of the associated *felstones* is partly decomposed into kaolin.

The *Felstones* vary from fine and compact to granular and porphyritic; some are very silicious (*felsytes*); others very felspathic. In colour they are of various shades of grey, blue, purple, green, and white. They are not in much, if any, request. Those near Roundstone, margining Galway Bay, have already been mentioned. In N.W. Mayo they are not very numerous. There is an exposure of them with dykes on Clare Island, Clew Bay; as also some dykes N.W. of Nephin, and others along the north coast. (G. S. M.)

In the metamorphosed Ordovician and Arenig (?) rocks are dykes of *euryte*, with their associated granitic roots at Lugnanon. These seem to be of Silurian age, as they run into the interbedded sheets (*Bundorragha euryte*) that extend from the Atlantic eastward to Loughs Mask and Corrib. They are of various shades of purple and green, and some of them are nice-looking stones, and polish well, and might be used for ornamental purposes, especially those near Lough-na-foeey, where they are variegated and streaked. They do not seem to have been utilized for building purposes; good stone being so easily procured everywhere.

The *uchinstones* are most varied in age and character. All the intrudes, dykes, and sheets associated with the Ordovicians, Arenigs and Cambrians (?) are changed into varieties of hornblendyte, hornblendic gneiss, and hornblende-rock; those least altered being pyroxenic-hornblendic. In the Silurians of Galway there are beds and

intrusions of *diabase* (?), while in the different groups of strata there are intrudes and dykes of *melaphyre* (Carboniferous ?) *dolerytes* and *basalts* (probably Cainozoic). Peculiar rocks that weather easily, forming great roads or ravines, with perpendicular sides, are probably the roots of the interbedded Silurian whinstones. These rocks are not sought after; yet the friable whins should make good fertilizers, especially if used as top-dressing on the boggy, mountain slopes.

In N.W. Mayo there are whinstones of different ages. The Tertiary Dolerytes and Basalts occur very frequently; for the most part as dykes in the granitic and metamorphic rocks, but sometimes in the Carboniferous. They vary in character and in composition. In the Carboniferous Limestone, a little northward of Killala, there is an intrude of a very coarsely crystalline doleryte, which is partly ophytic. It polishes well, but unfortunately it generally contains a quantity of iron, which comes out under the influence of the weather. As it rises, however, in large blocks, and is very hard, it ought to be suitable for sea-walls, piers, and such like rough work.

In the Little Cannavar Island, Lough Corrib, there is an intrude of actinolite and tremolite rocks, which should be capable of being economically used in the manufacture of black glass.

[This trade is almost totally neglected in Ireland. At the Artizans' Exhibition in Dublin in 1885, there were exhibited black glass bottles made from tremolite rocks from Co. Antrim. This, however, does not seem to have been turned to much account. There would be a fine opening for bottle works in Galway, the materials being close at hand.]

Hornblende and Ophite Rocks.—These are sometimes metamorphosed whinstones; sometimes they are root-rocks and other intrusions, allied to basic elvan or granitone. None of those found in this territory have as yet been utilized for ornamental purposes; yet it is very possible that suitable stones might be procured, more or less in connexion with the Ophyte, in the following localities.

Co. Galway. In connexion with the two tracts of Ophyte near *Lough Ballard* and a short distance east of it, in the wild tract westward of Roundstone.

About half-a-mile south-west of *Bunowen Castle*, near the north shore of Galway Bay.

To the south and south-east of *Glendollagh*, or *Lough Garroman*, in the tract of hornblende-rock.

In the hornblende-rock tract at *Arderry Lough*, north of *Screeb*.

In connexion with the large *Dauros* exposure of Ophyte, eastward of *Ballynakill Harbour*.

At *Curraghuongaun*, N.W. of the *Kylemore Castle* garden, there is a sort of eclogyte, a specimen of which was polished; it is a handsome clouded and streaked green-and-brown stone.

In *Leamnaheltia*, near the south shore of *Lough Fee*, in the mountain tract northward of *Kylemore Lake*; also possibly in connexion with some of the other areas of hornblende rocks in the *Co. Galway*.

Co. Mayo. To the west of the *Corvookbrack* granite, a little south-west of *Loughnahaltora*, in the townland of *Derrygarra*, there is a stone very like the Swedish "green granite," but brighter and handsomer.

In *Glencullen*, north-east of *Mweelrea*, and westward of *Doo Lough*.

In two or three places in the neighbourhood of *Lugaloughaun*, which lies in the hills between *Leenaun* and *Westport*.

Possibly, also, in connexion with the long, wide tract of *Croagh Patrick* Ophyte, that extends for miles south and eastward of *Clew Bay*; and perhaps on *Clare Island*, in connexion with the exposure of similar rock. Part of the *Clare Island* exposure is light green nice-looking stone. The more silicious portions of the *Croagh Patrick* Ophyte take a good and lasting polish, as may be seen in numerous polished fragments on the beach of *Clew Bay* and of *Clare Island*. This class of stone, however, would be expensive to work and polish.

"Stones for the rough rubble used in the backing of the walls of *Galway Docks* were procured out of the excavation for the dock. The rock is a very hard greenstone, in part porphyritic [Hornblende-rock]. It took an enormous quantity of the best special steel to drill holes in it, and of dynamite to split it. The stuff came out in large, irregular lumps, one to two tons weight, without bedding or cleavage. These were used in concrete for backing, while the face-work was of limestone from *Menlo* where we could have got blocks of almost any size required; but the blocks used were about five to twelve cubic feet." (*James Price*.) The hornblende-rocks of the neighbourhood of *Galway town* are

very irregular in structure; but associated with them are hornblendytes or schistose rocks, more or less regularly bedded.

In various parts of the Cos. Galway and Mayo the slates or shales, and grits or sandstones of *Ordovician* age, graduate into schists and quartzytes respectively; in Co. Mayo a portion of the Silurians in the neighbourhood of Louisburg is changed into schists.

Most of these schists, as they rise in flat-bedded stones, are very suitable for walling, and are very generally used in the different areas.

OUTLYING TRACT. A few miles north-east of Dunmore, Co. Galway, at the north-east extremity of Slieve Dart, there is an exposure of *felstone*. This stone is of a flaky character, which unfits it for building purposes; but it is useful as road metal.

About nine miles eastward of Westport, south of Ballyhean, there is a small hill of metamorphic rocks (*Ordovician*). These are in no place well exposed; yet among them we can find an ophytic hornblendic rock, or perhaps an *eklogyte*. This stone may possibly be suitable for ornamental purposes, as a specimen of it, obtained with a great deal of trouble, cut and polished easily and well. It is of handsome and unique green and brown shades of colour.

EAST MAYO, SLIGO, ROSCOMMON, AND LEITRIM.

The *Granitic rocks* are found associated with the schists, in the hills known as the Slieve Gamph and Ox Mountains. The largest exposure is in the former, constituting a long, wide, south-west and north-east tract, extending from the country north of Castlebar, past Lough Cullin and Foxford, into the Co. Sligo; while there is a much smaller tract further north-east in the Ox Mountains in the vicinity of Lough Easky: the former being on comparatively low ground, and the latter at a higher elevation. In the schist country, between the large mass of the granite and the Carboniferous rocks of the Castlebar district, there are small intrudes, courses, and veins of granite.

All the above granites are foliated, and now appear as a coarse gneiss, more or less similar in appearance to the Laurentian gneiss.

[There is a marked distinction between this gneiss and the granitic gneiss of the Co. Galway. The latter, although in places somewhat similar in aspect to that of north-west Mayo and Sligo, is evidently the result of the extreme metamorphism of

sedimentary rock, as it graduates on the one hand into schist, and on the other into metamorphic granite. This, however, is not the case in regard to the rock now being described; as although foliated, and having its foliation in the same planes as that of the associated rocks, yet it is evidently an intruded rock, as it has well-defined, sharp boundaries at its various exposures.]

It has been pointed out by *Symes* that this rock could be raised, in some places, in blocks of very great size; but it works badly across the foliation, and is therefore not very suitable for cut-stone purposes. *Wilkinson* states "the rock is even-grained, but hard and difficult to cut; seldom used for any purpose, as there is very little demand for it in the immediate neighbourhood, and the limestone and sandstone are abundant in other parts. In a few places in roads, bridges, and common walls it has been used in the way in which granite is commonly employed, being split for rough-shaped quoins and common walling, and no dressing being necessary, it has proved sufficient for such purposes. Large blocks could be obtained, and it appears to be an even-textured stone, although the quality varies along the boundary of the district."

The granite has been very generally utilized in local County works: for instance, the Pontoon Bridge and Hotel were built of it.

Whinstones.—Intrusions of this rock occur in the schist area in the following localities, viz. on the north-eastward side of the Lough Easky granite; also four miles N.E., and about the same distance W. of Lough Cullin; also over three miles N.E. of Castlebar, and at Derrycoosh, W. of the same. Whinstones occur in the Carboniferous Limestone, in the valley of the Moy, close to the S.E. margin of the schist, and to the north-east of Turlough; and (in a very long narrow strip) near Castlebar; and (similarly) near the village of Cushinsheeaun; and about three miles S.W. of Westport.

In general these stones are excellent for road metal, or as large blocks for foundations, or other similar rough work; the Cushinsheeaun course is cut by the Great Midland Railway, and stone from it was brought by that Company to Dublin for such purposes, when they were constructing the Spencer Dock; but the stone of the long course, near Castlebar, weathers to a considerable depth into a coarse sand, and is apparently the same class of rock as the "Bohernacolley" rock of N.W. Galway. This detritus, as has been mentioned, should be useful as a fertilizer.

Hornblende Rock.—Four or five exposures are met with in the granite and schists, north and south of Foxford; one about a mile south of that town, containing large crystals of hornblende, white felspar, brown and black mica, &c. All these rocks are foliated, the foliation being parallel to that in the adjoining granite or schist; but they have distinct, well-marked boundaries. The rock is very tough. (G.S.M.)

Felstones.—Very few intrusions of this rock are reported from this district. One occurs on the east slope of Letter Hill, westward of Castlebar.

As in other districts, the *Schists* that split into flat-bedded stones are suitable for walling, and are much used locally. In some places, as in the neighbourhood of Ballysadare, and in a more limited area south of Lough Gill, and about Nephin Mountain the ordinary schist is replaced by quartzitic rock or quartzyte. In the vicinity of Westport is the peculiar pebbly quartzyte, suitable for rough, heavy work, which has already been recorded among the ARENACEOUS Rocks (p. 285, *supra*).

OUTLYING LOCALITIES.

In the *Silurian* rocks of the Curlew Mountain range (Cos. Sligo and Roscommon) there are *Eurytes*, similar to those of Mayo and Galway (*Bundorragha Eurytes*, (p. 445, *supra*), except that these are associated with peculiar tuffs or tuffose rocks. There are also intrudes of whinstone.

[The *Silurian* eurytes in the Mangerton district, Co. Kerry, are associated with tuffs, or, perhaps more properly, tuffose rocks (p. 436, *supra*); those of the Killary district (Galway and Mayo) are usually not associated with tuffs; they occur only in the neighbourhood of Lough-na-foeey and the Kilbride district; but here the tuffs are peculiar, as in general there seems to be no hard boundary between them and the rocks that seem to be normal euryte. In the Fintona district, hereafter mentioned, there are other peculiarities; as rocks that seem to be true eurytes are divided up into plates, so thin that some of them may be described as coarse slates. Near Cushendall, Co. Antrim, the rock occurs only as an intrude.]

In the hills westward of Lough Gara there are several exposures of euryte, which has quite a normal aspect; yet the greater part of this is in beds or layers, from a few inches to a few feet in thickness, as though the exposures were, at least in part, tuffs or tuffose rocks.

In this neighbourhood, as also to the north-east of Lough Gara, there are some large dykes of whinstone.

Some of the whinstones are utilized as road-metal, and the eurytes and tuffs rise in nicely-shaped and sized stones, suitable for walling, while they seem to be capable of being dressed. Some of them cut and polish well, and might be employed for ornamental purposes; none of them, however, seem to be made use of, except for farm fencing. They are at high elevations, and generally not easily accessible, while sandstone abounds.

More or less similar rocks occur also in the western part of this hill range, near Ballaghaderreen, and in the Charlestown district. Some of the latter, however, are intrudes, unaccompanied by tuffs.

At the western extremity of the range (Co. Mayo), appearing from under the Silurians, there is a small tract of *metamorphosed rocks*, probably *Ordovicians*, appearing from beneath the Silurians. These rocks are more baked than micacised, many of them being *leptyntes*, or white-rock; these are represented on the geological survey map as felstone. They are generally very pure stones, and should be capable of being manufactured into kaolin. In this tract there is also an intrude of euryte, and smaller ones of a pyroxenic-hornblendic rock. The latter is a nice-looking stone, cutting and polishing well; but it is excessively hard, and rises in rather ill-shaped blocks.

In the townland of *Uggool*, near the north side of the mouth of Killary Bay, there is a tract of elvan, a small piece of which cut and polished well; it is of a mottled yellowish red or light salmon colour.

South-east of *Drumsna*, Co. Leitrim, in the *Ordovicians*, there is a small boss of whinstone.

In the promontory called the Rosses, three to four miles north-west of the town of Sligo, there is a small exposure of metamorphic rocks. They are principally schists.

DONEGAL, LONDONDERRY, TYRONE, AND FERMANAGH.

Of the rocks in this part of the territory, those of *Donegal* are the most important.

DONEGAL.

In the north-west of this county, in the baronies of Kilmacrenan and Boyleagh, there is a tract of gneiss and foliated granite, associated with eruptive granites (*gneiss series*), margined by areas of metamorphic rocks (*schist series*); the one passing gradually into the other. The metamorphic granite, gneiss, and schist seem to be due to one and the same action, while the older eruptive granite is allied to them like as is the granite in other metamorphic areas, such as those of Galway and Mayo. In Donegal a newer granite was intruded at a later time.

The older intrusive granite occurs principally to the westward, in a tract near the sea, to the northward and southward of Dunglow, and also further southward, in the group of hills at Barnesmore (Bluestacks, Croaghmagar, &c.), to the north-eastward of Donegal town.

The greater part of the younger granite occurs in the north headlands of the baronies of Kilmacrenan and Inishowen, it being in places much entangled with the associated schists, while extending from the granite tracts are massive courses of elvan and porphyry, which appear to graduate into basic felstones and whinstones.

These dykes and courses occur not only in the older rocks (*Metamorphosed Arenig* (?) and *Cambrian* (?)), but also in the later rocks (*Ordovician* (?) and *Llandovery* (?)); and it seems possible, if not probable, that the masses of granite may represent the laccolites, or roots of the sheets of Donegalyte, so conspicuous in the Killygarvan series of rocks (*Llandovery* (?)), occupying the county N. W., N. and N. E. of Rathmullen.

In the older rocks (*Cambrian* (?) and *Arenig* (?)) there were many intrudes and interbedded (?) masses of whinstone, which were variously altered, with the associated rocks, in accordance with the amount of metamorphism to which they were subjected; the whinstones being now represented by granitic rocks and different varieties of hornblende-rock. As some of the older sedimentary rocks were altered into gneiss, and others into schists, the latter being of all varieties down to nearly unaltered rock, so similarly the alteration in the associated intrusive rocks is of varied amount, some being greatly altered, and others only very partially so.

[The older rocks (*Arenig* (?) and *Cambrian* (?)), after their deposition, were distorted, contorted, thrust, altered, and invaded by granite and other intrusive rocks, and then denuded, before the newer series of rocks were deposited on them. This seems to be satisfactorily proved; for although the later rocks were subsequently greatly disturbed, displaced, and even inverted in some localities, yet there are still ocular proofs that one series lies unconformably on the other, as at a little north of the Malin Coastguard Station; while in places the basal beds of the later series contain thrust fragments of the granite, gneiss, &c.; thus proving the metamorphism and denudation of the older rocks prior to the accumulation of the others. Afterwards, however, the later rocks, and probably the older ones, were subjected to another period of metamorphic action.]

In the rocks (*Ordovician* and *Llandovery* (?)) above the unconformability, there are also many intrudes and sheets of whinstone (*Donegalyte*), and a few intrudes of felstone; while in places, associated with the *Donegalyte*, are small and large masses of agglomerate and tuffs; the most extensive recorded being in the neighbourhood of Croaghan, Fanad. The lower portion of the later rocks is usually partially altered, while the upper series (*Kilgarvan group*) is generally not so. If the latter are altered, it is, for the most part, in isolated detached portions. In the *Kilgarvan group* are some well-marked, apparently interbedded, sheets of *Donegalyte*.

As a general rule, felstones and allied rocks are not common in the Co. Donegal; still in the northern and north-western parts there are many courses, dykes, and patches of elvan, porphyry, and felstone occurring, as adjuncts of the intrusion of the later granite.

The later granite occur in rocks that seem to belong to the older stratified formations (*Cambrian* (?) and *Arenig* (?)); but that they were intruded later than the accumulation of the younger formations (*Ordovician* and *Llandovery*) is proved by dykes of the porphyries and felstones from them being found in the latter. There are also in a few places intrudes of these granitic rocks in what may be outlying tracts of the later rocks.

In the western part of the county, especially, there are dykes of small dimensions, sometimes very numerous, of either melaphyre or doleryte, which are considered by M'Henry to be of the same age as the Tertiary rocks of the Co. Antrim.

Among these different rocks there are some which are eminently suitable for building purposes, and for cut-stone and polished work; but on account of their out-of-the-way position, very little

use has been made of them up to the present time ; and very few quarries have been opened, except for road and farm purposes. Now, however, inquiries are being made about them, and it is proposed to work them in several places. Some of the localities where they have been, or might be, worked with advantage, will now be mentioned.

GRANITE AND GNEISS QUARRIES.

Barnesmore, about half-way between Donegal and Stranorlar, about eight miles from each. Granite, porphyritic, red, or flesh-coloured, can be raised in large blocks, and is capable of a good and fine polish.

The Barnesmore red granite was, a few years ago, worked by Mr. Flynn, who transported it by rail and road to the *Bessbrook Granite Works*, Co. Armagh, to be manufactured for monumental, architectural, and other cut-stone purposes, and for polished work. In the quarry, which was at or near the top of the south-west slope of the Gap, large blocks were detached and rolled down into the valley, there to be scabbled into blocks suitable for carriage. The work seems to have been discontinued on account of the great expense of the carriage. However, now that the West Donegal Railway has been opened, this cost of carriage might be much diminished.

In this neighbourhood there is also a bright-grey granite, fine-grained, compact, and more or less similar in aspect to the well-known Castlewellan stone, Co. Down. This grey stone has only been worked for local purposes.

[In places in this granite area there are veins of granitite, fine-grained, felspathic, and nearly micaless, similar to the rock now in use in the manufacture of glass.]

Minnagran, about nine miles from Glenties.—Gneiss ; grey, coarse, gritty, loosely aggregated, and difficult to work. The quartz and felspar are in nearly equal, though variable, proportions, some beds being more micaceous than others. In the vicinity this is known as the "*Minnagran millstone*."

In the Glenties district there are large courses, or elongated tracts, of a coarse granitic gneiss, similar to those of the Castlebar district, Co. Mayo. Here, as in the Co. Mayo, the rock was

originally an elvan or granite course, which subsequently was foliated and changed by metamorphic action into gneiss. This rock has not been utilized ; but it is very suitable for coarse, heavy work like country bridges or harbour works.

Dunglow granite quarries.—In this neighbourhood, as stated by experts who have lately examined the country, there are inexhaustible supplies of granites of varied colour and texture, which are proposed to be worked by a company. Mr. Philip Brannon's report states that they range "from dark and almost purple reds into graphie, mottled and cloudy ; rich bright red ; bright red ; faint tones of red (salmon, pink, rose, &c.) ; through deep grey, or blue, and very light silvery grey, into a beautiful resplendent white granite." The stones proposed to be worked are "fine and even-grained, without verts, and capable of receiving an even and good polish. As they are regularly jointed, both horizontally and vertically, the stones can be raised with very little waste. They are of long scantlings and large dimensions." The granite boulders scattered about would afford blocks large enough for any practical purpose. The stone in these boulders is perfectly sound, without any apparent joints or flaws.

It is proposed to work the stone principally *in situ* ; finishing-work, such as planing, polishing, &c., being carried on in a factory near Dunglow. From these works it is intended to send into the market "cut and polished slabs, columns, lintels, sills, steps, base-ments, string courses, facing, dressing, or any other requirements for monumental or architectural ornamental works ; also rough stone suitable for paving-sets, kerbing, quoins, facings," &c.

The quarries or places in the Rosses specially named are :—*Burton Port*, rich mottled ; *Leckena*, dark to light salmon and light red ; *Lefinn*, pink and brilliant red ; *Garron Hill*, or *Toberkeen*, graphie mottled (purple and red) ; *Dunglow Hill*, light and dark greys ; and *Lough-na-geeragh*, white.

As far back as 1865, Mr. William Harte, County Surveyor, Co. Donegal, who had used the Dunglow granite for various purposes in Derry and elsewhere, brought these granites under the notice of Griffith, Jukes, Haughton, and Scott, for their beauty and other qualifications. As these authorities approved of them, they were subsequently worked for a time by Messrs. Harte and Owen, especially at Lefinn. However, at that time polished

granite was not appreciated as it is now, and as the works did not pay, they were discontinued. Mr. Harte specially mentions that the Dunglow granite improved in colour with time, when used in facings and such-like work in Derry.

Croagh-na-Shollog.—On the western flanks of this hill, about a mile south of Dunglow, Mr. J. R. Kilroe records a very red granite, capable of being raised in large blocks.

Glenveagh, west of Kilmacrenan.—Foliated granite; grey, durable, not too hard; used throughout in Glenveigh Castle. (*J. Cockburn*.)

Carrick, north of Milford.—Red, quartzose.

Glenieraragh, south of Glen Lough.—Gneiss; grey quartzose, compact, even-grained, durable, evenly jointed, and can be raised in naturally square blocks. Was used in the bridges of the new road from Glen to Barnesbeg.

Barnesbeg, between Kilmacrenan and Creeslough.—Granite; grey and red; even-grained, but of different textures; splits, punches, and dresses well. The stone occurs as loose blocks in the gap, no regular quarry having been opened; used for dressings in Kilmacrenan church and in various other places. (*J. M'Fadden*.)

In different places in the large granite and gneiss area that extends from the Atlantic north-eastward to Glen, there are veins and courses of good stones, suitable for nearly any dressed work, in which quarries might be opened. Quarries, however, are few, as the surface-blocks, or the neighbouring schists, supply stones sufficient for local county purposes, while, except from Lefinn, they do not appear to have been exported or used out of the district or its neighbourhood.

Magherararty, Bloody Foreland.—Granite; grey, durable, not too hard for a granite; used in the quoins, sills, window-heads, piers, chimney-caps, &c., of the Curvane Point Coastguard Station. (*J. Cockburn*.)

Torries, Arran Island.—Granite; pinkish-grey; coarse, but evenly crystalline; contains hornblende and sphene.

Lackagh Bridge, between Creeslough and Glen.—Foliated granite or gneiss; bright-pink, of a rare and beautiful shade, also shaded grey; even-grained. A hand specimen was inspected by Mr. Sibthorpe, who considered it ought to polish well. Used for dressed stone purposes in the Carrickart Roman Catholic church.

Finford, Fanad-within-the-Waters.—Granite; grey, pink, and shaded; even-grained; very easily worked; cuts and polishes well; used in some of the dressed work at Mulroy, or Manorvaughan House.

Arraheernabin, on the north coast, near Fanad Lighthouse.—Granite; bright grey; even-grained; compact; works and dresses easily and well. Used in part of the dressed work in the new Lighthouse, Fanad, and at the Portsalon Pier, Ballynastocker Bay. A very general characteristic of the granite to the south-west of the last, in the tract between the road and the sea, is a natural and easy splitting up of the rocks into long rectangular pieces; and it may be suggested that these might be utilized in the construction of cheap and durable fences, similar to those in use in the Co. Carlow.

At the present time (1888) the Earl of Leitrim is exhibiting at the Olympia Exhibition, London, cut and polished granites from the neighbourhood of Mulroy Bay. It is proposed to form a company to work them. According to *Mr. Manning* the stones have been procured from the following places:—

Doaghmore.—Bright-grey and pink; even-grained. The polished specimens from these quarries were from surface-stones. The quarries are now being properly opened up, to get out a better quality.

Melmore, Rinmore, Ballyhunan, and Arraheernabin.—Principally grey granite, of a good quality; suitable for monumental and cut-stone purposes. "Specimens of green and red granite are found at Rinmore and Arraheernabin; but as yet no quarry has been opened on them, and what they may be suitable for is not known."

Tory Island, at the Lighthouse.—Grey granite, very similar to the above at Arraheernabin. Raised in the excavation for the gasometer, and used in the structure.

Dunaff, Inishowen.—A granite very similar to that of Doaghmore, at present not worked.

The Metamorphic granites are often good stones for building purposes; but many are obliquely foliated (*query*, metamorphosed quartzites(?)) and these are not so; some quartzose varieties of the latter, however, are very suitable for road-mending, and are used for that purpose.

[These obliquely foliated granites are very similar in appearance to the felsitic quartzites and sandstones among the schists and other rocks. The quartzites, sandstones, and said granites all occur in irregular beds, and the oblique foliation in each is of the same character, while the constituents of the quartzites and sandstones are such as would easily change into those of the granites. At the south entrance of Barnesbeg and elsewhere, there are rocks which it is difficult to say whether they ought to be classed as quartzite or granite. All these circumstances have led me to believe that most, if not all, of the obliquely foliated granites were originally sandstones which have passed through the stage of quartzites into their present condition. Others of the metamorphic granites are in mass, or in massive courses similar, respectively, to the intrudes and courses of the hornblende rocks and the Donegalyte, in the schists and allied rocks. This may lead us to suppose that they were originally intrudes of exotic rocks into the derivate rocks with which they are now associated.]

In Ireland, as has been mentioned in the INTRODUCTION (p. 394, *supra*), there is generally more or less freedom from systems of "grain" or parallel spitting planes in all the granites of metamorphic origin: this, however, is not so noticeable in Donegal as elsewhere, as some of the metamorphic granites split remarkably well. Those, for instance, at Barnesbeg are reported by the stonecutters as "kind, plugging easily in all directions, durable, of good colour, yielding large and square scantlings, and capable of long and heavy bearings." (*J. M'Fadden.*)]

Malin. At the north extremity of Inishowen there is very quartzose gneiss with subordinate micalytes and hornblendytes (*Metamorphosed Cambrian (?)*), which, to the southward, are overlaid unconformably by quartzites (*Ordovician(?)*). The typical gneiss to the westward is remarkable, as the foliation therein is horizontal. The quartzitic gneiss is all more or less flaggy, and suitable for building purposes, and some veins of it for flags. The locality is very inaccessible, and the stones have only been used for local purposes, and in the buildings of the Telegraph Station for the Trans-Atlantic Shipping.

ELVANS AND FELSTONES.

Courses and dykes of these rocks are well exposed in the neighbourhoods of Falcarragh, Dunfanaghy, Rosscuill, and other places in the north of Donegal, as also in some localities in the south of the county, while generally they are not common elsewhere. In some of the exposures there are nice-looking stones; but they are very little sought after, and no quarry of note seems to have been opened in any of them.

As is usually the case elsewhere, the stones of this class do not appear to be capable of producing blocks of as large or long scant-

lings as the granite ; nor are they suited for long bearings, although some appear capable of bearing heavy weights.

“ East-north-east of *Crow Hill*, near Castlefinn.—Felstone dyke ; speckled greenish-grey ; fine-grained ; nice-looking.

“ *Tirinisk*, near Castlefinn.—Porphry ; purplish ; spotted with white and dark-green.

“ East-north-east of *Crossy Hill*.—Felstone ; bright grey ; speckled ; fine-grained.

“ *Woodland*, near Killygordon.—Euryte ; speckled purplish ; fine-grained.” (*F. W. Egan.*)

Arran Island, west side.—Porphyry ; purplish grey ; mottled ; speckled with white and black ; compact.

Bloody Foreland.—Elvan or porphyry ; purplish ; handsome.

WHINSTONE.

(Donegalyte, diabase, dioryte, doleryte, &c.)

The majority of the Donegal whinstones are rough and ungainly, or are rotten, or come out of the quarries in more or less coarse shingle, and are more suitable for road metal than for any other purpose. In places, however, there are really valuable stones, especially in some of the dykes and other intrudes ; but these have been used only in a few places for cut-stone purposes.

Ballyboe and Millbrook, a little west of Rathmullen.—Light colour ; green and mottled ; porphyritic to fine-grained ; compact ; durable ; can be raised of long scantling, with considerable transverse dimensions ; capable of long and heavy bearings ; cuts and dresses on any face ; polishes well.

The local name for the quarry is *See-agh*, while the stone is very generally called “ Ballyboe green granite.” About the year 1820 the quarries were opened during the building of the forts at Inch and at Rathmullen, while more recently blocks were used in the construction of the Rathmullen Pier ; and for cut stone purposes in pillars for entrance gates, quoins, &c. (*J. M'Fadden.*)

It has been quarried in both townlands, and hand specimens take a ready and good polish. The porphyritic variety, when polished, is a light-green, with a whitish mottling, and would be effective as columns. Some of the measured blocks were over 15

feet long. This stone, like others of the same class, becomes a little discoloured at first, but subsequently freshens to a bright green.

Columbkil Lake, eastward of Millford.—A dyke at the north end of the lake. Green; fast colour; fine-grained; durable; dresses easily and well on any face; can be raised of fair scantlings; capable of long and heavy bearings. The quarry was opened to procure quoins, sills, window-stools, window-heads, while building the Hospital at the Milford Workhouse; since then it has remained idle.

Stone more or less similar to that at the Columbkil Lake dyke, but generally more bedded, occurs in other places in that neighbourhood, as also west of Mulroy Bay, and near Letterkenny.

Woodquarter, N.W. of Millford and west of Mulroy Bay.—Green, flaggy, with a peculiar purplish iron staining, or parting in the joint planes. Small quarries were opened in several places to procure stones principally for walling purposes. The stone dresses well, but in one quarry the mineral in the joints disqualifies it; as even a small portion of one of these partings will stain the stone and those in its vicinity. In a second quarry these iron partings do not appear to be so prevalent, and good sized stones might be raised.

Rough Park, about two miles N.E. of Letterkenny.—Apparently a bedded sheet of whinstone; green; flaggy; compact; dresses easily. Has been quarried in two places, and used as building stones, quoins, kerbs, and flagging, in Letterkenny. Durable as a building-stone and as kerbs, but not so good in flagging.

Lissnanan, about a mile N.N.E. of Letterkenny.—A very similar stone to that of Roughpark; lately used in Letterkenny for kerbs.

In the county between Lissnanan and Roughpark there are exposures of from two to four sheets of these green flaggy whinstones; but these are quarried only in the above townland. At the present time cut and dressed stone required in Letterkenny is brought all the way from near Strabane, Co. Tyrone; but this expense might be saved if a good and proper quarry was opened in one of these whinstone exposures. The vein in Rough Park is very favourably situated, being in a rise of ground, and near a good public road; while the stone in it seems capable of being raised of sufficiently large and long scantlings to suit the requirements of the town.

In Inishowen these flaggy whinstones are not uncommon, and have been quarried in different places: those best known are as follows:—

Dunmore. Six miles from Carndonagh, in the Culdaff direction.—Can be raised in blocks and slabs from 6 to 12 feet long; capable of long and heavy bearings; cuts any way, but the blocks are more generally sawn; polishes well; of a good green colour; used extensively in the Poorhouse and other buildings at Carndonagh; also for tombstones. (*George Baggs.*)

Croagh. Seven miles from Carndonagh, and five from Moville.—A very similar stone to that at Dunmore; but does not weather as evenly. (*George Baggs.*)

Dunree. Close to the Fort where, as well as in the Lighthouse, it was used for flagging, window-sills, &c.; a very similar stone to that at Dunmore. The greater part of the Fort is built of a kind of quartzite, which dresses fairly well; this was raised in the immediate vicinity from a vein in the Ordnance ground.

Some of the Donegalites and other whinstones, especially the dykes associated with the bedded sheets in the Killygarvan (Rathmullen) district, seem suitable for paving-sets, channels, and kerbs. None of these stones, however, have been tested.

METAMORPHIC WHINSTONE.

(Hornblende, Hornblende-rock, and Hornblendic Gneiss.)

The principal zones in which the hornblendic-rocks occur are those northward and southward of the tract of gneiss and granite; they occur, however, in other places also, but principally where the associated rocks are more altered than usual, as in the Lough Derg district, in the south-eastern part of the county. As in other regions, so here also a common characteristic of the courses is a rib of hornblende-rock or gneiss in the middle, margined on each side with hornblendic-schist (hornblende). But some of the masses of whinstone, especially when in or close to the gneiss, have been completely changed into hornblende.

Many of the hornblendites are capable of being raised in more or less shapely, flaggy masses; but in general they work rough across the foliation, or plane of the flag. Most of the hornblende-

rocks and gneisses are best suited for coarse, heavy work, as piers, sea-walls, and such like. However, a few were observed to be more or less regularly-jointed, and to rise in naturally square blocks. These ought to be suitable for the large setts used in street-crossings, as on account of the difference in the hardness of their mineral constituents they wear rough.

Kinder varieties of the hornblende-rock, which are generally more or less ophitic, or epidotic, have been noted as being very similar to some of the "Swedish green granite" now in the London market; these, therefore, should be capable of being utilized for ornamental and monumental purposes. As, however, up to the present time, no quarries have been opened, it is not possible to give information as to the size and shapes of the blocks that could be procured. We can, however, state that some hand-specimens took an excellent polish, and were of a bright olive-green colour.

Hornhead. About two miles from Dunfanaghy.—Greenish; crystalline; slightly foliated; used locally.

Goldrum. S. W. of Lough Salt.—Green; slightly ophitic; can be raised in fair-sized, rather even-shaped blocks. Slabs of this stone were used in some of the old structures of the vicinity, and as farm-fences.

The hornblendytes are, in places, favourably reported as building material. According to *Wilkinson*, they were extensively used in Glenties. Some varieties, however, are inclined, on exposure, to become "iron-masked."

SCHIST.

The micalytes, phyllytes, and sericytes are very much in request for general building purposes in the districts where they occur, and even outside them, as they rise in flat-bedded, suitable stones; while in some places they are regularly jointed, and rise with natural faces. According to *Wilkinson* they are most durable.

Those in use, are, however, often badly selected; some of them are highly feriferous, and if used as building-stones, the iron rapidly decomposes, and the stone becomes "iron-masked," giving the structure in which it was used an unsightly, rusty appearance. Among other places that might be mentioned, the use of badly-selected schists is very well illustrated at Ardara, and its neigh-

bourhood, the aspect of the village being quite spoilt thereby. Another place where this is well seen is on the road from Kilmacrenan to Dunfanaghy, near Creeslough.¹

If the planes of foliation in the schist coincide with those of the lamination, and if at the same time the rock is compact, free from many joints, and thin-bedded, it will produce flags. Good thin and thick flags, as mentioned in a former Paper, occur in various places (pp. 247 and 317, *supra*).

Barnes Lower. N.W. of Kilmacrenan, near the south entrance into Barnesbeg, *Anglice* little Gap.—Purple flags; highly micaceous; from about two to three inches thick; can be raised of fair sizes. Locally used for flagging, sewer-covers, &c.

[As these flags abound in the hills to the eastward, they might be extensively used in the erection of cheap effective and durable farm fences, similar to those that are in use near the Bangor slate quarries, and other places in Wales. The first cost of such fences would be more than that of those at present in use; but they would be much more effective and durable.]

Losset. North of Gartan Lake.—Flags similar to those at Barnes Lower. Used in the neighbourhood, and in Letterkenny and Rathmelton, for kerbing, flags, &c.

The quarries in the schists are generally small, having been opened merely to procure stones for local uses. Among the quartzites there are some stones suitable for flagging, and others for heavy work, such as sea-walls and foundations. These have been already mentioned in the description of the Arenaceous Rocks (pp. 247, 317, and 325, *supra*).

LONDONDERRY.

Towards the centre of the county, extending north and south from Lough Foyle, to and beyond Dungiven, is a basin of *Carboniferous* rocks. To the westward of this basin, with a few small exposures to the east thereof, are metamorphosed rocks. Those to the northward, coming in from the Co. Donegal, seem to be of *Ordovician* age, and are not as much altered as those to the south-

¹ In the Co. Wicklow the "iron-masked" rocks are locally called, from their appearance, "burnt-rocks," while for a similar reason the hills south of the East Oveca Mines are called the "Burnt Mountain."

east of the country; the latter being part of the Tyrone rocks, which are probably the equivalent of the *Arenig*, or, perhaps *Cambrian*.

Associated with the Arenigs of Slieve Gallion are intrudes of granite, elvan, porphyry and felstone; while, in places both in these and the Ordovicians, are whinstone dykes of different ages.

The granite is not a durable rock, the exposures are of small extent; and as they adjoin the sandstones, there is no necessity to use them for building purposes. Some of the granites are handsome stones, especially those of *Carndaisy*; but Egan is of opinion that, as they are so much jointed, they could not be raised in blocks of sufficient size to be profitably used for ornamental purposes.

The elvan and felstone are in the neighbourhood of the granite: they, too, are not in repute. Some, however, are handsome; but as they are in out-of-the-way situations, and would be expensive to work, it seems unnecessary to dwell upon them further.

The *Whinstones* occur as dykes in scattered localities, and are not generally used as building materials; they are, however, employed as road metal.

Within the area of its exposure, the schist is the stone principally used for walling. It rises in flat-bedded masses; and as the joints are generally more or less regular, they give good faces for building purposes. This rock cannot, however, be dressed across the grain.

At PREHEN (p. 279, *supra*), and several other places in the vicinity of Londonderry, there is a "book schist," or a rock with even laminæ, which give the transverse section the appearance of a number of leaves of paper laid one on another in a pile. This, has been extensively used in the town and its suburbs. Near Limavady the schist contains a good deal of iron, which comes out under the influence of the weather, giving the walls a dingy appearance. At Lislane, S.E. of Limavady, the schist was quarried for the railway works. (G. S. M.) Near Muff is an argillaceous schist (*phyllyte*), which rises in coarse, heavy slates. Elsewhere in the area are numerous quarries, the schists in these varying greatly, being micaceous, argillaceous, hornblendic, quartzitic, &c., but all more or less suitable for walling.

In the eastern part of the county, and extending in that direction into the Co. Antrim, and southward into Tyrone, are

Eocene Whinstones (*Basalt and Doleryte*), the western margin of the great sheets of these rocks, which occupy the greater part of the Co. Antrim.

Associated with these, to the northward, in the vicinity of Portrush are granite roots (*granitone*, or *highly crystalline diorite*); and in other places, as near Croagh, to the south, are conglomerates and other tuffs. In the Croagh neighbourhood there seem to have been one of the volcanic vents, from which the sheets were poured out.

The granitone occurs in the Skerries, off Portrush, and in Portrush Head, where it was extensively quarried for use in the Harbour Works.

In the *Basalt* region, the harder varieties of doleryte and the *clinkstone* (the local name for the fine basalt that has a metallic ring), are the materials generally used for ordinary building purposes. They can be raised in large well-shaped blocks, and scapple freely. Some, especially the clinkstones, polish well, and are very similar to, if not identical with those used in some of the monuments and statues of the ancient Egyptians and Romans.

The abutments and piers of Coleraine Bridge are built of these stones; they have also been used in Moneymore for quoins and string-courses, the facings being of the white limestone, as also in numerous other towns, and the country-houses in the area, sometimes only for quoins and dressings, but sometimes, also, for facings and rubble work. In the basalt region the quoins and dressings are sometimes of the white limestone, while the facings are basalt.

TYRONE.

In the east of the county, coming in from the counties of Antrim and Londonderry, is a small portion of the Ulster Tertiary Basalts and Dolerytes, while the northern part of the county is composed of metamorphic rocks, probably equivalents of the *Ordovician* and *Arenig* or *Cambrian*, the latter being much more altered than the former. Associated with these are metamorphosed igneous rocks with veins, dykes, and other intrudes of granitic and other newer exotic rocks. The *Arenig* (?) schists, especially their associated metamorphosed exotic rocks, seem worthy of notice.

In the south of the county, and extending westwards into Co. Fermanagh, are Silurians, with their associated granites, elvans, eurytes, and whinstones.

The descriptions of the Tertiary Whinstones of the Co. Londonderry are generally applicable to those of this county. Locally they are used for building purposes, especially for quoins and such like; where they have an effective appearance, if the facings are of white limestone, or sandstone. For finer work the far-famed sandstones of Dungannon are more generally used.

The *eurytes* and their adjuncts occur both as granites and elvans in the older rocks, the metamorphosed Arenig or Cambrian, and as intrudes and interbedded sheets, with their associated tuffs, in the Silurians (*Old Red Sandstone type*).

These granites, generally speaking, although often very handsome red or variegated rocks, are shingly, or easily disintegrated, or full of joints, and consequently cannot be raised in blocks suitable for either general building or ornamental purposes. Some of the intrudes of porphyry and euryte, however, give well-shaped, good-sized blocks, and might be utilized, except that the sandstone of the county, being more easily worked, is preferred by the architects and stonecutters.

A little west of *Deveney Bridge*, to the south-east of Omagh, there is a large exposure, for the most part a compact purplish rock, which rises in large blocks and cuts, and polishes well; it is also easily plugged and dressed. In part of the mass the rock is an amygdaloid, spotted white and red, a really handsome stone, well worthy of being more known than it is at present. Some of the eurytes also, when porphyritic, are handsome; but they are often affected by a structure that causes them to rise in thin-bedded stones.

The bedded eurytes at Glenbeg, Shane Barnagh's Sentry Box, &c., are associated with tuffs. Some of these eurytes are very peculiar, as they are traversed by a structure exceedingly like bedding, which subdivides them not only into slabs, but also into what might even be called slates. This is very conspicuous in the neighbourhood of Back Bridge, where they have been quarried for slabs, for flagging, and for roofing purposes.

There are scattered dykes of felstone in the metamorphosed *Ordovicians*, a more considerable intrude occurring near *Creggan Hill*, about eight or nine miles S.W. of Newtownstewart.

In general these eurytes are ignored for building purposes, on account of the far-famed sandstones of the county being preferred; yet they are a good, effective, permanent stone, as seen, for instance, in the Coastguard station at Cushendall, Co. Antrim, where an identical euryte was used, as hereafter mentioned.

There are also a few dykes of whinstone in the Silurian rocks, but, as a general rule, these are used only for road metal.

Within the Slieve Gallion district (*metamorphosed Arenig, or Cambrian*) there is a granite very similar to that of Omey Island, Co. Galway, which is evidently newer than the associated schist, but older than the Pomeroy series (*Llandovery* (?)); and there are granites and elvans which seem to be the root-rocks of the interstratified *Silurian* eurytes. The older granite could be raised in large blocks, and is suitable for ornamental purposes; but the Silurian granites, although often a handsome red stone, are nearly always so much jointed that they could only be procured in stones of small dimensions.

The *Hornblende-rock* is greatly varied in character. In general it is very coarsely crystalline; but sometimes it is a fine blackish or grey hornblendic granite. In this tract there are Ophytes and Ophito-hornblendic rocks, some of the latter being very like the so-called "Swedish green granite." These rocks appear capable of being utilized for ornamental purposes. The localities in which they occur have been given in the description of the ophytes (p. 159, *supra*).

In the metamorphosed Ordovicians, west, south-west, and south-east of *Castlederg*, there are protrudes and courses of hornblende rock, as also to the westward of *Sion*, a little N.E. of *Newtownstewart*, on the S.E. slope of Bessy Bell, and a few miles S.W. of Gortin, in Ballynatub mountain. (G. S. M.)

Within the *schist* district, as about Strabane, Castlederg, and elsewhere, this rock is ordinarily used for common buildings. As to character it varies from fine argillaceous to more or less gneissose. Near Castlederg the surface is covered with many loose blocks of this micaceous rock, which are used for building. They are frequently split by an ingenious application of fire on the top of the stone, the expansion resulting from which is made to separate the stone in any part required." (*Wilkinson*.)

FERMANAGH.

In the north-west part of this county, near Belleek and Pettigoe, there is a small tract of metamorphic rocks, probably equivalents of the *Arenig* or *Cambrian*, coming in from Co. Donegal. These rocks, like those of the Slieve Gallion district, Co. Tyrone, are very much altered, and there are in them some interesting varieties of hornblende rock.

There are large dykes of whinstone in the *Carboniferous* and *Silurian rocks*, while in the latter, near the bounds of Co. Tyrone, there are also eurytes, more or less similar to those in that county. These rocks are not made use of, except to a small extent for road metal. (*T. Plunkett.*)

ANTRIM.

Overlying the greater part of this county are the well-known extensive sheets of *Eocene* (?) basalt and doleryte, and their associated agglomerates, conglomerates, and other tuffs, with, in places, intrudes of trachyte and granitic rocks (*granitone* and *nevadyte*).

In the neighbourhood of *Carrick-a-rede* there seems to have been one of the principal volcanic centres, the remains of the old volcano being still more or less visible, consisting of large masses of agglomerate, conglomerate, and more or less fine tuffs, cut up and displaced by numerous dykes and other intrudes of basalt, doleryte, and more crystalline rocks.

Slemish is considered by Traill to have been a volcanic vent. "It forms a bold ridge, 3000 feet long and about 1000 feet wide, which rises abruptly from 300 feet to an altitude of 1437 feet. It is an intrusive mass of dark, greenish blue, crystalline doleryte." In numerous places the sheets were due to fissure eruptions, the dyke that now fills the fissure merging into the sheet. This can be well seen at the iron mines in Glenarm.

Another well-marked volcanic centre was *Tardree*. Here, however, the adjuncts of the outburst were principally acidio rocks (*trachytes* and *nevadytes*), on which, in places, are lying

raised-up portions of the doleryte sheets. Associated with the trachyte and nevadyte (the latter locally known as *Tardree porphyry* and *Tardree granite*) are some tuffose rocks, looking very like the Brohlthal of Germany, which, when manufactured into a cement, is called *Trass*, and is extensively used in the embankments in Holland. Whether the German and Antrim deposits are similar as to composition, has, however, still to be proved. Up to the present time the latter has been considered to be useless.

The Tardree volcanic outburst is probably one of the latest of those in the north-east of Ireland, the trachytic rocks bursting up through the basaltic sheets, and throwing up a small cone, partly lava and partly tuff, to be afterwards more or less modified by marine and atmospheric agencies.

In BELFAST, in the *Post Office and Water Commissioners' Office*, Bessbrook granite, Co. Armagh, was used; in the *Bank of Ireland*, Donegall-street, Newry granite; shops in *Ann-street*, capitals and columns, Goraghowood granite; and *Queen's Bridge*, Castlewellan, Co. Down, granite.

The Eglinton Chemical Company have lately opened quarries in the basalt at *Bookis* and at *Ballintoy*, between the Giant's Causeway and Ballycastle. They are sending into the market paving-sets $4'' \times 4'' \times 4''$, $6'' \times 5'' \times 3''$, $5''$ to $7'' \times 6'' \times 3''$ to $3\frac{1}{2}''$, $7''$ to $10'' \times 7'' \times 3\frac{1}{2}''$ to $4''$, $9'' \times 7'' \times 4\frac{1}{2}''$, $6'' \times 4'' \times 4''$, and all sorts of crossings, channels, kerbs, &c., with waste for macadamization.

The harder varieties of the doleryte and the "clinkstone," or basalt that has a metallic ring are generally used in the basaltic area for building purposes, as they can be raised in well-shaped blocks of various scantlings, and will scabble easily. "Whenever it occurs, tabular, massive, or columnar, it makes a very good stone for rubble work. It hammers fairly well, and is most durable; it is not used for cut-stone purposes, because it is so difficult to work, and has a very dark, forbidding colour." (*W. Gray.*)

"At and near Ballymoney and Coleraine it is of a better working quality than in the south of the county, where it is harder, and has sometimes been used for moulded work." (*Wilkinson.*)

"The nevadyte or *Tardree granite* is procured from a quarry

some five or six miles north of Antrim. Grey, granular, durable; works well. Used for dressings, steps, quoins, piers, &c., in churches, country buildings, and other public structures in almost every town in Antrim." (*W. Gray.*)

In the north-east part of the county, in the Ballycastle district (barony of Cary), there are whinstones of *Carboniferous* age, as also metamorphosed intrusive rocks, associated with the tract of schists (*Ordovician* or *Arenig*). These schists and whinstones are very little used, as sandstone occurs in the immediate neighbourhood.

A little northward of Cushendun there is a tract of a handsome red elvan, which cuts and polishes well; but, unfortunately, it is so cut up with joints as to rise in pieces of small dimensions. (*A. M'Henry.*)

In the N. E., near Runabay, there is a similar elvan of a brighter red; a very handsome stone. (*R. Clarke.*)

Associated with the *Silurian* conglomerates at Cushendall there is a purplish, sometimes lighter-coloured (dove colour), and porphyritic euryte intrude. The dove-coloured is a good, durable stone, and has been used throughout in the building of the Coastguard Station. The porphyritic variety ought to cut and polish well, and make a handsome stone. The dark-purplish variety is not approved of.

NORTH-EASTERN IRELAND.

[Down, Louth, Armagh, Monaghan, Cavan, Longford, Westmeath, and Meath. N.B.—Antrim, for convenience, is put along with N.W. and N. Ireland.]

Chronological Account.

The exotic and metamorphic rocks in this territory seem to belong to the following geological periods:—

ORDOVICIAN and LLANDOVERY—*Granite, Elvan, Felstone, Euryte, Whinstone, Tuff, and Metamorphic Rocks.*

SILURIAN and DEVONIAN (Lower Old Red Sandstone).—The Cavan granite is post-Ordovician and pre-Carboniferous; it ought, therefore to belong to the Llandovery, or Silurian, or Devonian times, probably Silurian; but this cannot be positively affirmed.

Similar remarks are applicable to the Slieve-Croob granite, Co. Down.

In the Ordovicians there are numerous dykes of whinstone, euryte, and felstone, which are cut off by the intrude of Mourne mountain granite. These must, therefore, belong either to the Silurian or Devonian periods, if that granite is of Carboniferous age; but if it belongs to the Triassic, then some at least of those dykes may be Carboniferous.

CARBONIFEROUS and PERMIAN.—The Mourne Mountain granite and elvan may possibly be of Carboniferous or of Permian age; but it appears to me more probable that they were intruded in Triassic times. There are, however, intrudes and dykes of whinstone, euryte, and felstone, which are older, and evidently either Carboniferous or Permian.

TRIASSIC.—The granites and elvans of the Mourne Mountain district, and their associated felstones, eurytes, and whinstones, as just stated, are supposed by me to be Triassic. South-westward of Carlingford Lough are the Barnavave, or Mount Fathom elvan and the Slieve Foze granitoid rock, with their associated whinstones, eurytes, and felstones, all being post-Carboniferous, while they seem to be pre-Tertiary, and were probably intruded during the Triassic age.

TERTIARY.—In the Carlingford district are dykes and other intrudes newer than the Slieve Foze granitoid rock, and all other rocks in the district, while some of them are apparently identical with the Tertiary rocks of Antrim. These rocks seem to have their granitic roots in the country westward of the Lough, and also in the great course of nevadyte coming up through the Newry granite (*Slieve Croob*) in the vicinity of Goragh Wood, Bessbrook, &c.

[Prof. Sollas has lately suggested that these are the remains of a very recent volcano in this district, the details of which he is working out at the present time.]

Territorial Description.

In some of the counties included in this territory no metamorphic nor exotic rocks are known to exist; those in which most are found are the counties Down, Louth, and Armagh, especially in the neighbourhood of Carlingford Lough.

DOWN, LOUTH, AND ARMAGH.

In the northern part of the Co. Down, near Comber and Newtownards, there are intrudes of whinstone in the *Triassic* rocks; these are principally used for road metal.

In the neighbourhood of Lurgan and Portadown, counties Down and Armagh, there is the southern extremity of the great Ulster sheets of *Eocene* doleryte and basalt; while at Market-hill and Poyntzpass there are some small intrusions of the same.

Dykes of whinstone, euryte, and felstone, are very numerous in the *Ordovician*, especially in the eastern coast section and in the hills. Many of these, as already mentioned, are cut off by the intrude of the granite of the Mourne district; but some seem to be adjuncts of that granite, while others are probably of *Tertiary* age.

“The mountains around Carlingford Lough yield a good series of granites, all nearly of the same colour, but differing in texture; the finest being from Castlewellan, and the most open, or spotted from Goragh Wood and Bessbrook. Stones of any size can be had from Castlewellan, and good stone for all purposes from any of the quarries.” (*W. Gray.*)

BESSBROOK GRANITE COMPANY, Co. Armagh. (*Thos. Flynn.*)

Five different qualities of granite:—

No. 1.—Bright-grey, spotted; probably the root rocks of the younger exotic rocks of the district, and allied to the *nevadyte* of the continental geologists; a very handsome stone; polishes well.

No. 2.—Bright-grey, fine-grained, very hard, durable; the typical *Newry* or *Slieve Croob* granite; here it is very hard, and eminently suitable for paving-setts, which have been supplied to the Tramway Companies of Wigan, Bristol, Chester, Southport, Newtown Heath (Manchester), Edinburgh, Chesterfield, St. Helen's, Swansea; and to the Corporations of Liverpool, Huddersfield, Preston, Chester, Salford, &c. Setts, 4" cubes, 3" × 6", 4" × 6", 3" × 5", 4" × 5" and 4" × 7"; special sizes if required.

No. 3.—Bright-grey; coarser than No. 2; it is not being worked at present.

No. 4.—Quarry in Barnesmore, Co. Donegal, as mentioned in the description of that county (p. 454, *supra*).

No. 5.—Rostrevor Quarry (Mr. Hewitt's), Co. Down. Anorthite syenite, of a bright-green colour.

The Company are prepared to supply all sorts of polished work in monuments, columns, and slabs, also pilasters, steps, sills, kerbs, channels, paving-setts, &c.

At the *Rostrevor Quarry* black paving-setts have been manufactured for many years; blocks are now being raised there which are sent to the Bessbrook polishing works, and there manufactured into monuments, slabs, &c. This stone is superior in colour to the Swedish "green granite."

[Specimens of the Irish polished granites are to be seen in a collection at the Science and Art Museum, Kildare-street, Dublin.]

MOOR QUARRIES, NEWRY, Co. Down—(*Campbell & Son*).—These quarries are in the *Newry* or *Slieve Croob* granite, and are capable of supplying blocks of the largest sizes required. Colour, rich sparkling grey; very durable; polishes well.

The polished granite is supplied for monumental and architectural purposes of any design or sizes required; also bases up to 40 cubic feet; plinths, and kerbs, from 5" × 6" to 9" × 12"; coping, ashlar steps, landings, sills, crossing and channel-stones, paving-setts, macadamization stone, and gravel. The sills can be supplied in all required sizes.

ULSTER STEAM-POLISHING COMPANY, Belfast—(*Robinson & Son*).—Principal quarries, No. 1, at Goragh Wood, Co. Armagh, and No. 2, at Castlewellan, Co. Down.

No. 1, *Goragh Wood Quarry*.—More or less similar to the Bessbrook, No. 1, quarry (*nevadyte*, or Tertiary granite). A very handsome spotted grey stone; takes a rare polish. Can be raised in blocks of large sizes.

No. 2, *Castlewellan Quarry*.—Is a peculiar variety of the *Newry* or *Slieve Croob* granite; the black graining of the grey being elongated in oblique lines, giving the stone an unique and chaste

aspect. It can be raised in blocks of almost any size. This stone was used in the Albert Memorial, Hyde Park. Stones up to 25 tons weight, and of great length, being supplied. It was also highly commended by Sir J. N. Douglass, Engineer to the Corporation of Trinity House, London, who used it in the reconstruction of Bishop Rock Light House, Scilly Isles, after a careful personal comparison of different granite quarries in Scotland, Cornwall, and Ireland. It was most favourably reported on, as being well adapted for resistance in batteries, after experiments at the Royal Arsenal, Woolwich.

On account of its extreme hardness it is eminently suitable for paving-setts. This hardness seems to be due to the re-arrangement of the minerals in the original granite by subsequent metamorphic action.

The Company are prepared to send into the market all requisites, polished, rough, &c., necessary for monumental, architectural, building, and other purposes, columns, slabs, pilasters, steps, sills, kerbs, channels, paving-setts of any required sizes, and granite gravel for concrete blocks for pathways.

Besides the stones at present being worked there are others that appear worthy of being inquired after. At *Rostrevor-quay*, Co. Down, there is a dyke of a good green stone. This has been quite recently quarried for monumental purposes, as mentioned in the notice of the quarries of the Bessbrook Polishing Company. It had been previously worked for paving-setts and building purposes.

Fathom Mountain, Co. Armagh. In places in this mass of elvan there is a handsome pinkish-grey porphyry, spotted pink, white, and black. This rock has not been opened up as yet, and its capabilities are unproved.

Barnavave, South. A very fine-grained greenish-grey speckled elvan; cuts and polishes well. This stone, if it could be procured in sufficiently large blocks, ought to be useful for ornamental purposes.

As in this tract there is a great variety of exotic rock (grey, green, red, &c., elvans and whinstones), there ought to be other stones capable of being utilized in the hills (Cos. Armagh and Louth) westward of Greenore, and those S.W. of Newry. Traill says of the Carlingford felstone-porphyry, that from the great

depth to which it weathers, no attempt has been made to open quarries in it. "It is highly porphyritic, of a pale pinkish colour, and appears to be a very beautiful stone," as seen in the cuttings for the Newry and Greenore Railway. He therefore is of opinion "that good quarries might be opened with advantageous results."

The *Mourne Mountain* granite at the margins of the intrude usually becomes an elvan. To the north-east, near Newcastle, it has been quarried for use in that town. Usually it is even-grained, pink mottled grey, and much coarser than the other granites of the Territory.

In the southern part of the county Louth, in the *Ordovicians*, there are numerous beds, dykes, and other intrudes of whinstone and euryte, as also beds of tuff more or less similar to those already mentioned in the Co. Wexford; they do not seem to be much utilized except for local purposes. Some of them, however, appear suitable for paving-setts.

These are very numerous along the coast section in the neighbourhood of Clogher Head, while inland they appear about *Collon*, S.W. of Dunleer, coming in from the Co. Meath.

MONAGHAN, CAVAN, LONGFORD, WESTMEATH, AND MEATH.

West of Bellanagh and S.W. of Cavan there is a limited tract of fine-grained grey and reddish granite, which is described as metamorphic and *post-Ordovician*. "The granite is generally broken up by irregular jointing, and thus can be but little used for building purposes." (G. S. M.)

A few felstone dykes have been noted in the vicinity of the granite.

In the Co. Meath there are whinstones S.E. and S. of Kingscourt, coming up respectively through the *Coal-measures* and the *Triassic*. To the N.E. of Navan, and at Slane, and to the S.W.E. and N.E. thereof, extending into Co. Louth there are in the *Ordovicians* numerous long exposures of whinstone, felstone, and tuff locally utilized.

Near Duleek and Naul, the latter being just within the Co. Dublin, there are similar rocks in the *Ordovicians*. Some of the whinstones near Balbriggan were considered by *Jukes* to be eminently suitable for paving-setts.

In Monaghan, Longford, and Westmeath there are not any metamorphic rocks; nor does there seem to be any exposure of exotic rocks in those counties.

VII.—GENERAL SUPPLEMENT.

[Read January 9, 1889.]

(In this Supplement is given such information as has been obtained since my several Papers on this subject were published. I may, however, refer briefly to the suggestion that some of the oldest Irish rocks, although not the equivalents of the Laurentians, may nevertheless be possibly Pre-Cambrian.)

INTRODUCTORY.

AGNOTOZOIC.—The improbability of any of the Irish rocks being equivalents of either the Huronians or Laurentians has been already suggested. It must, however, be remembered that in America there is a great interval between Huronian and Primordial strata, and that the "Gap rocks" have been found to exist in Maine, Manitoba, and other places in America. Chamberlin has proposed to call the time of their deposition the Agnotozoic Epoch, which suggestion was adopted by the late Dr. Irving.

Dr. R. D. Irving, *Pre-Cambrian Rocks, Lake Superior Region*, p. 454, 7th Annual Report, U. S. Geol. Survey, 1885-86.

AGNOTOZOIC OR EPARCHÆAN,	{	Keweenawan.
		Huronian (of Logan).
		Other Groups.
ARCHÆAN,	.	Laurentian (including Upper Laurentian).

The American Primordials would seem, from their fossils, to be the equivalents of the Welsh Cambrians; and the latter, up to the present, are considered by most people to be a portion of the same formation as the Bray Head Series. For this classification, however, there does not seem any good reason, as both were classed together solely because one was considered to be the oldest English and the other the oldest Irish formation. But on examination it is found that both lithologically and palæontologically they are quite different.

For some time it has been known that there are Pre-Cambrian rocks in Scotland, while Blake, Hicks, and others believe

they have proved their existence in England and Wales; therefore the presence of Pre-Cambrian rocks in Ireland may also be expected.

In favour of a Pre-Cambrian age for the Bray Head Series, the following may be noted:—The Welsh Ordovicians pass downwards conformably into the Cambrians; but the Leinster equivalents of the Ordovicians do not pass thus into the Bray Head Series, as there was evidently a considerable interval between the accumulation of these distinct groups of rocks. Furthermore, in the brief description of the Baginbun Promontory, Co. Wexford (*Supplement, Irish Arenaceous Rocks, antea*, p. 326), it was shown that to the south of Fethard there is an unconformability between the Ordovicians and a group of older fossiliferous rocks; while the latter are quite unlike in every way those of the Bray Head Series; it therefore seems probable that they may be a portion of the true Cambrian. Under these circumstances it appears expedient that the rocks of the Bray Head Series should be called by a separate and distinctive name: and for them the term “*OLDHAMIANS*” may be suggested.

The Pre-Cambrian age of the *Oldhamians* seems to be also suggested by the geology of Galway and Mayo, where the equivalents of the *Ordovicians* pass downwards conformably into a great thickness of strata, quite distinct from those of Bray Head; while in the Mullet, or N. W. Mayo, this group of rocks lies unconformably on certainly one, and possibly two, groups of older strata.

After careful consideration, it seems to me highly probable that the *Oldhamians* of S. E. Leinster, and the older rocks of the Mullet, and other places in W. Mayo, are *AGNOTOZOIC*; while some of Griffith's older rocks in the Cos. Tyrone, Londonderry, Donegal, and Antrim, might also possibly be similarly classed.

So far back as 1861, the late Prof. Harkness, in his Paper “On the Rocks of portions of the Highlands of Scotland . . . and their equivalents in the North of Ireland” (*Jour. Geol. Soc. Lond.*, vol. xvii., p. 270), expresses the opinion that the *Malin Head gneiss* is of the same age as the upper *Archæan Rocks* of *Sutherland, Scotland*.

CARBONIFEROUS SANDSTONE.—It had been anticipated that small outliers of Carboniferous rocks might be found to occur, if

properly searched for, on some of the high hills in Donegal and elsewhere. During a late visit of Dr. A. Geikie (Oct. 1888) to S. W. Donegal he discovered, on Slieve League, two considerably-sized tracts of Carboniferous Sandstone; while it seems probable that a third, but smaller one, exists further north, to the west of Ardara, as the breccia and conglomerate in places on the shore of Loughrosbeg Bay are similar to the basal Carboniferous conglomerate of other places.

MINES AND MINERALS.

Gold.—Slieve-an-Orra, Co. Antrim.—It now appears that the tradition of gold being found here was due to a promoter of the Antrim Mining Co. having made the statement, on the supposition, that *orra* signified *aurum*. (See note, p. 488.)

Silver.—Camaderry, Glendalough Lead Mines, Co. Wicklow. Associated with the lead of this lode were found some handsome sprays of native silver; also the peculiar form of calcite, called Schiefer Spar.

Silver Copper.—Silver in the west of Cork seems to occur as often in tetrahedrite as in chalcopyrite.

Silver Lead.—Clonmines and Barretstown, Bannow Bay, Co. Wexford. *Fraser*, in his "Statistical History," states that the Danes had a mint at Clonmines. From Mr. *George Griffith's* "Chronicles of the Co. Wexford" we learn that there was a mint at Clonmines in the reigns of Henry VIII., Edward VI., Mary, and Elizabeth. The first record quoted refers to Clonmines Silver Mines, in July, 1550 (King Edward's reign), and others refer to it and Barretstown up to 1565 (Elizabeth's reign). During this time the mines appear to have been worked on and off under different agents. In 1552 they were worked by Almains, or Dutch miners, under Joachin Gunderfilgen; while, in 1565, the agent was one Walter Pepparde; but on account of the "constant quarrelling going on between persons trying to get the mines into their power they ceased to be worked for many years." The Clonmines mine seems to have been extensive, yet there is now no record of its site. Barretstown was reopened about the year 1840; but, as already mentioned, it was not a success. Other mines, worked by the English in the sixteenth century, are those near Enniscorthy.

Iron—Manganese.—Calliagh and Tattin Heive, Co. Monaghan, S. S. W. of Rossmore Park. According to Adeney, this contains 35 to 50 per cent. of iron, and about 7 per cent. of manganese. The outcrop of the lode has been traced for over half a mile. (*W. F. de V. Kane.*)

The analysis of the iron ore of Logwood Hill, Calliagh, is given by Mr. W. E. Adeney as follows:—

Ferrie oxide,	42·2
Alumina,	7·55
Manganese peroxide,	6·24
Cobaltous oxide, }	·03
Nickelous oxide, }	
Lime,	·35
Magnesia,	·21
Phosphoric acid (P_2O_5),	·03
Water (expelled at 120° C.),	3·47
Loss (on gentle ignition),	3·21
Insoluble matter ignited,	37·00

The Insoluble matter contained 29·51 of silica and a trace of titanio acid.

Copper.—Tullig, near Anascaul, Dingle Promontory, Co. Kerry. There is an old tradition that copper was found here. (*W. M. Hennessy.*)

Molybdenite and Molybdene.—Murvey, Roundstone, Co. GALWAY. In this locality the oxide (molybdene) seems to be in considerable quantity, accompanying the sulphide (molybdenite).

Nickel.—Glenisky, near Kylemore, Co. GALWAY. In the magnesian rock there is a trace of nickel. (*J. R. Kilroe.*)

Steatite, or Pyrophyllite.—Co. DONEGAL. Moneydarragh, $3\frac{1}{2}$ miles N.W. of Moville, barony of Inishowen. There is a bed, 3 to 6 feet thick, so soft that it can be dug out with a spade; and in the strike of this bed, two miles to the N.E., near Crossroads, a similar rock was observed, but of less thickness.

Owenbeg river valley, 10 miles west of Letterkenny, and S.W. of Gartan Lake. Strings and veins of steatite run along the bedding, of a buff-coloured dolomyte, from $\frac{1}{2}$ an inch to 3 and 6 inches thick; this steatite seems to be very pure and suitable to be used as *French chalk*. (*A. M. Henry.*)

Ballintemple Mine, Woodenbridge, Co. Wicklow. According to the record of Sir W. W. Smyth and the late Mr. Wylie, the thickness of the lead vein was five inches; while we learned, through the late Mr. Henry Robinson, Captains Barclay, and Argall, sen., also from various miners, that the vein rarely exceeded that thickness, while often it was less. Eventually it dwindled down to a mere string, which was driven and sank on, without finding any improvement. No one in the county seems ever to have heard of an eighteen inch vein (*Geol. Survey Memoir*, Sheets 138 and 139, p. 31), while it seems remarkable, *if such a Champion lode was discovered*, that immediately afterwards the mine should have been abandoned.

In Appendix D (*ibid.*, pp. 41 and 42) three of the Plans, &c., Nos. 5, 6, and 7, lodged in the Mining Record Office, are omitted; while the numbers given, 5 to 20, are not those on the lodged documents. For the survey of the old workings the public are indebted to Captain P. H. Argall, and not to Captain Higgins, as is incorrectly stated (*ibid.*, footnote, p. 29). For other inaccuracies, see descriptions of the Ovoca Mines (pp. 109–119, *supra*), and Capt. Argall's Paper on the East Ovoca Mines (*Journ. R. G. S. I.*, vol. v., N.S., p. 150).

Ovoca Mines.—The following details, not previously given, may be of importance to future adventurers:—

Although Weaver seems to have had some doubts about it, yet previous to my survey the general opinion was, that the *Mineral Channel* had a similar strike and dip to those of the country rocks. During that examination, assisted by Captain P. H. Argall and the late Gerrard A. Kinahan, I proved it was not so, as the channel creeps gradually across the strata, and a careful and prolonged examination led to the following conclusions:—

A large fissure gradually opened, during which process it was being filled with laminated *fault-rock*, the strike of the laminæ being parallel to the walls of the fissure, which now dip southward. Subsequently, in the western portion of this *channel* (Ballymurtagh, Ballygahan, Tigroney, and West Cronebane), a newer fissure also gradually opened along the north margin of the mass of *fault-rock*, this fissure gradually filling with laminated sulphur ore; its laminæ being parallel to the foot (north) wall of the lode, while it is slightly oblique in dip to that of the hanging (south) wall. A

peculiarity in this Main sulphur lode is, that in depth the ore is more coppery than higher up. Afterward in this portion of the channel, to the south of the Main sulphur lode, perpendicular lenticular fissures opened. A few are transverse, but in general they are longitudinal, but slightly oblique to the main lode; so that, although distinctly separate from the latter in West Cronebane, Tigroney, and Ballygahan, in Ballymurtagh they joined into it; yet in no case, in depth, do they seem to have penetrated it. These perpendicular veins were known as the "Copper lodes," and all of them in the country east of the Ovoca river were extracted by Weaver.

In the middle portion of Cronebane (Yellow Bottom) the main sulphur lode seems to have been proved by Weaver, and subsequently by Argall. As the "copper lodes" do not extend into it, it was called in Weaver's time "Dead ground."

In the east portion of Cronebane (Magpie Mine), Connary, and Kilmacoo, the phenomena were different, as here two nearly parallel fissures opened in the faultrock. In the north fissure or lode the filling stuff, although laminated, consisted largely of black and greyish white flucan (hence the name Magpie), while the ore was coppery, friable, and not of the hard nature of that in the western mines. This north lode, although in one place heaved north, is always at the north margin of the faultrock, as far N.E. as the Kilmacoo N. and S. fault, where it and the channel appear to be heaved north about six furlongs, as shode stones occur thereabouts in the townland of Rockstown. The south lode is not so continuous, as it is cut out in Connary by an intrude of felstone; it is a flucan course, containing veins and pockets of kilmacooite (see p. 114, *supra*). As the profitable reduction of this peculiar ore is still undiscovered, the lode has been very little explored.

South of the Magpie and the Yellow Bottoms there are five or six E. and W. lodes apparently in the Country rocks. They were proved by Weaver and were being explored by Argall when the mines were stopped; they are known as Madam Butler's, Yellow Bottoms, Morgan's, Discovery, Blueburrow, and Raddle lodes. Madam Butler's lode contains copper ore mixed with kilmacooite, and was worked in part by Weaver.

The North lode, Ballymurtagh, Ballygahan, and Cronebane (Castle Howard), occur in fissures nearly parallel to the mineral

channel. The last was discovered during my survey, while its exact position was proved by Captain Argall. This explorer also opened up Weaver's Boat level in Castle Howard, and found that the driving had been discontinued a short distance west of where it ought to have cut the North Cronebane lode. This level is an important consideration if the East Ovoca mines are again worked, for if it was continued eastward this North lode would be out in depth, while the Magpie and Connary mines would be unwatered, thereby saving the expense of pumping.

The minor lodes in the country north of the Mineral channel are in nearly parallel fissures. Those in Knockanode, to the north of Ballymurtagh, were very extensively explored without success. Plans and sections of the Knockanode workings are lodged in the Mining Record Office, London.

It should be put on record that the Carysford Mining Company opened a cast across the country from Kilcarra to the sea, near Arklow Rock. They are said to have only found two small lodes of lead and one of sulphur; for some reason they missed finding the source of the great Gossan ramp, in the S. W. portion of the Glenart Woods.

LIMESTONES AND MARBLE.

DONEGAL.

Derrisligg, south of Glen Lough.—A very pure compact white limestone, but apparently not of very great extent. (*S. B. Wilkinson*.)

In the neighbourhoods of *Carndonagh* and *Culdaff*, Inishowen, a dark, nearly black limestone, that splits, punches, and chisels well; can be raised in good-sized blocks. (*G. Baggs*.)

Crohy, south-west of Dungloe.—A handsome, peculiarly streaked, spotted and mottled black, green, and white opicalcyte. "Thin-bedded, and not of any great extent or quantity." (*J. R. Kilroe*.)

Polished specimens of this stone can be seen in the Geological Museum, Trinity College, Dublin, and in the Science and Art Museum, Leinster House, Dublin.

DUBLIN.

In the new railway station, Westland-row, also in the Loop Line, City of Dublin Junction Railway, the limestone for rubble

work was procured from Jordan's quarries at Rathgar, and Bayley's quarries at Finglas. The Rathgar stone is very good for foundations, coming out in stones about 12 to 15 inches thick ; stones from one ton to twenty-five cwt. are easily obtained. The layers are very even and the stone tough.

The Finglas stone is not as even on its beds, yet the masons prefer it for faced work, as it is more easily worked, and gives a more even face. The strata, however, are generally irregular, and the quarry beds are not easily kept horizontal in the work, there being so many "nuts."

For the Loop Line the limestones for out-stone purposes were procured from Tullamore, Cavan, and Meath. (*T. B. Grierson.*)

GALWAY.

Merlin Park.—In the lower black beds of this quarry there is a most beautiful compact marble, equal and similar to the Italian that is used for clock-stands and the like. This superior stone, unfortunately, has been found, as yet, only in lenticular patches of very limited extent.

MAYO.

On the road from Beltra Lough to Castlebar, about three miles from the latter, there is a nice-looking white Limestone. (*R. G. Symes.*)

SANDSTONES.

KILKENNY.

Kiltorcan Quarry, near Ballyhale.—Buff-coloured, fine-grained sandstone (Novaculite, or honestone), well known from its fossils. Here there was formerly a considerable trade in the manufacture of hones for local use and exportation.

The stone is eminently suitable in every way for the purpose, being of good quality, and readily splitting into convenient sizes. Unfortunately, however, the trade has long since died out. (*A. M'Henry.*) (See SANDSTONES, p. 488).

CLAYS AND BRICKS.

ANTRIM.

Belfast Delph.—In the loan collection at the Free Library, Belfast, was exhibited a lady's shoe made of blue and white delph. It is marked "Belfast, 1707." Through Messrs. Patterson and Swanston I learned of a second, figured by Benn in his History of Belfast, and marked "Belfast, 1724.—*M. H.*R.*" These authorities, and others who have examined the shoe, question its having been made in Belfast, as it is identical with some old Scotch and English wares.

DUBLIN.

In connection with the brick trade of this county, Dr. Frazer has called our attention to a lease of part of Rathfarnham, dated 14th January, 1679, in which there is a covenant giving his family power "to dig up any part of said premises, and to burn bricks thereon."

[In the enlargement of the Westland-row railway station the facing of the walls is composed of perforated Bridgewater brick of first quality, and the hearting of Cardigan bricks of second quality; except in some of the walls that had not to carry much weight, where there is a Bridgewater facing and granite backing. In the arching are red Kingscourt bricks (*Thompson, Bros.*), and Kingtown bricks of second quality. For the brickwork in cement in the piers for the roof, and the columns, were used first quality Chester fire-bricks, about 2½ inches thick. In the City of Dublin Junction Railway (Loop Line), the principal bricks were buff, from Torrington, North Devon, and Aston Hall; dark-brown fire-bricks from Chester, and Farnley brick, with enamelled faces in places where light was required to be reflected; in the Loop Line enamelled bricks were used in the St. George's-quay abutment.

At Kingscourt some of the bricks are pressed, while others are wire-cut. The pressed brick used in the facings were of good quality, and those used in places on the Wicklow line for small works appear to have stood well. The wire-cut, or unpressed bricks, have sometimes a tendency to split vertically, or across the brick, when set on their proper bed: this happened in many instances, as they broke across, although well flushed in mortar.

In the case of a brick splitting horizontally the fracture is not nearly so injurious as when it splits vertically. In the first case the superincumbent weight will generally keep the pieces in position; but if there is a vertical crack it is much more likely to cause a settlement. The Kingtown bricks were used at the Merrion Station, Dublin and Kingtown Railway, in a parapet wall next the sea; but whether the sea air affected them or not, they have become greatly pitted on the face, and have deteriorated considerably. (*T. B. Grierson.*)]

WEXFORD.

Killiane Pottery and Delph Manufactory.—At the end of the seventeenth century, during the Cromwellian settlement, a Quaker, Jonathan Chamberleyne, from Staffordshire, established a pottery in Great Killiane, on Wexford Harbour. It was first for coarse pottery, made from the clay of the country; but about 1719 he established a delph manufactory, when, it is supposed, he imported materials from England. The delph was such a success that china was attempted. This, at first, was so successful that five kilns were built and loaded, but in the baking they proved a total failure, and the ruin of the adventure. Some of the ware made at Killiane was in use in that neighbourhood as late as 1876. (*Griffith's Chronicles of the Co. Wexford.*)

GRANITE, ELVAN, &c.

CO. ANTRIM.

Tardree Volcanic Rocks.—It is the opinion of M^r Henry that the trachytic rocks at Templepatrick and Tardree were laccoliths which originally did not appear at the surface; their present exposure being due to denudation. They were intruded after the greater part of the basalt; but that there were intrudes of the latter after the genesis of the laccolith is proved by the basaltic dykes that traverse them.

The tuffose rocks of Tardree, in appearance somewhat like the Brohlthal of Germany, were tried by Mr. Ritchie of Belfast, who failed to make a hydraulic cement from them.

At Templepatrick M^r Henry has discovered a portion of the basal Eocene conglomerate which has been baked by the trachyte, and the contained flints changed into *agate*s.

DUBLIN.

There is a handsome porphyritic granite in the Three Rock Mountain, containing very large salmon-coloured crystals of felspar (Microcline). This stone, when polished, is very effective, and would be suitable for inside work, but for outside work the mica (muscovite?) would be prejudicial, as it would weather out. Two polished slabs of this rock are exhibited in the mineral collection in the Museum of the College of Science, Stephen's-green, Dublin.

Granite for footpaths and crossings ought to be very carefully selected. This is not the case in Dublin, where some of the stones at present in use are quite unsound, and will in a short time rot and wear away; while others have unsound corners, which rapidly decay, leaving holes in the paths and crossings. Such unsound corners result from the cutting of too large a flag or crossing-stone out of a granite block, the outer part of which is weathered. The effects of these rotten corners are conspicuous in many of the pathways and crossings.

LEITRIM.

Arigna Flags.—Recently a light railway has been constructed to the collieries in this district, and it is now proposed to extensively work the excellent coal-measure flags (p. 277, *supra*) which formerly were very little utilized on account of the difficulty of transport.

MONAGHAN.

Two and a-half miles S. W. of Smithborough there is “an evenly crystalline, dark-blue basalt dyke. Two other dykes occur in the county E.N.E. of Castleblayney.” (G. S. M.)

In *Lisserard*, *Knockaturley*, and *Ramany* there is a dyke of green, mottled white, granitone, over a mile and a-half in length. In the latter townland, about two miles from the Monaghan railway station, the rock is exposed in a water-cut, and is found to be a sound, good stone, which appears capable of being raised in good-sized shapely blocks. A specimen was sent to Mr. Brindley, of Westminster, who highly approved of it for polishing purposes. It seems to be also well adapted for paving-sets. (*W. F. De V. Kane*.)

CO. WICKLOW.

Aughrim and Tinnakilly Granite Quarries.—The soda granites (keratophyre) in these localities, as previously mentioned, are more or less pyritous, and are supposed to be of Carboniferous or later age. They occur as intrudes in the schists and in the older granite (*Haughton's Leinster Type*), having been probably “laccoliths,” their present appearance at the surface being due to denudation.

Some of these rocks on weathering become clouded, or spotted with rust; but the better stones are only more or less speckled,

these different appearances being due to the varying amount of iron present. From a careful examination of the place it would appear that usually the laccoliths consist of irregular shells or slightly-curved layers; the outer shells, as well as the adjoining schist, being highly impregnated with iron (Marcasite), while in depth or nearer the centre it is not so. In depth the rock seems to become less and less pyritous; so that, if *well selected*, clean bright stones may be procured. There are also in these granites black or greyish, more or less pyritous, micaceous eyes, the majority of which, especially if they have a pyritous margin, weather into a rusty spot on the face of an otherwise bright clean stone.

From the structures in which this stone has been used we learn that the badly selected stone will become rusty, and remain so, while the better class, after a time, lose the rust speckles, and become clean and bright. It would appear, therefore, that the faces of the good stones, if treated with acetic, or else weak hydrochloric acid, might be artificially weathered, thereby getting rid of all the surface iron prior to the stones being used. The iron in the "eyes," except where it occurs as a rim, might be similarly got rid of.

"In the new railway station, Westland-row, Dublin, the granite for rubble was brought from Kingstown, Sandycove, and Dalkey, most of it being procured while doubling the line from Kingstown to Killiney. The granite for cut-stone purposes came from Dalkey, Kingstown, and Aughrim, Co. Wicklow. In the Loop Line (City of Dublin Junction Railway), the granite for cut-stone purposes has been principally procured from Aughrim, Co. Wicklow, but some is Co. Dublin granite." (*T. B. Grierson.*)

ADDITIONAL NOTES.

GOLD.—According to W. Fitton, who wrote in 1812, gold was found in the King's river, near Hollywood, Co. Wicklow.

SANDSTONE.—*Dunmore* and *Croagh*, Co. Donegal. The stones in these quarries were described by the quarrymen as "of the nature of whin;" they were therefore put down as such in p. 461. However, when since visited, they were found to be really fine compact sandstones of either Ordovician or Silurian age; therefore they should have appeared among the arenaceous rocks in p. 248.

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